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THE ECONOMICS OF VALUING MARINE RECREATION:

A REVIEW OF THE EMPIRICAL EVIDENCE

by

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I. INTRODUCTION

The question addressed in this report is whether the available economics literature provides a basis for estimating the benefits to marine recreation attributable to the water pollution control programs of federal, state, and local agencies. By marine recreation, I mean those recreation activities that take place on tidal estuaries as well as the open ocean waters and on adjacent beaches. The recreation activities that have received the most attention in the empirical literature are fishing, swimming and related beach activities, and boating.

I have approached the fundamental question outlined above by seeking answers to four more specific sets of questions. First, what does the literature tell us about the economic values that people place on being able to undertake specific recreation activities and on being able to visit specific recreation sites? Second, what attributes of recreation sites matter to people? And what values do they place on changes in these attributes? Third, what do we know about how policy affects those attributes for which data on values are available? And fourth, is it feasible, and if so, under what conditions, to use the value information obtained for specific sites and/or activities to estimate values of changes in activities or attributes at other recreation sites or to synthesize or aggregate the individual studies into an estimate of the national benefits of marine water quality improvements? In other words, are "benefits transfers" and "benefits aggregation" possible.

I should point out that these four specific questions focus on the values associated with recreational uses of the marine environment and do not address the possibility of nonuse values associated with environmental changes

to this environment.¹ Although there is a substantial empirical literature on the nonuse values associated with terrestrial mammals and birds and other features of the terrestrial environment (for example, visibility), I am aware of no empirical estimates of nonuse values associated with changes in marine water quality.²

In the next section of this report, I provide a brief review the economics of recreation. In subsequent sections, I take up each of these four questions in turn. In Section VII I present my conclusions. An Appendix includes summary descriptions of all of the empirical studies included in this report.

II. THE ECONOMICS OF RECREATION

The value measures reviewed in this study have been obtained by utilizing either some form of the travel cost model of recreation demand (including the hedonic travel cost model), the random utility model (RUM) of the choice of recreation activities and recreation sites, or some form of contingent valuation (CVM) survey. In addition, two of the studies reviewed for this report used a hybrid approach to modeling recreational behavior in which equations for predicting the rate of participation in recreation activities were estimated and then per unit values drawn from other recreation demand studies were used to calculate the monetary value of recreation participation. In this section, I briefly review each of these methods and

¹For a discussion of conceptual basis of non use values and a review of the empirical evidence, see Freeman (1993a) and references therein.

²The literature does contain estimates of nonuse or existence values for a beach nourishment program (Silberman, Gerlowski, and Williams (1992) and marine mammals (Samples, Dixon, and Gowen, 1986, and Hageman, 1986).

discuss the interpretation of measures of value that can be derived from each.³

The Travel Cost Model

The travel cost model of recreation demand is based on the assumption that the cost of traveling to a site to participate in some recreational activity is an implicit price. Travel cost includes both out of pocket costs such as gasoline and tolls and the cost of time. The travel cost model is usually applied to data over a period of time sufficiently long so that at least some of the people in the sample visit a site or undertake an activity several times. Data on numbers of visits is regressed on explanatory variables including the implicit price of a visit to estimate the representative individuals' demand curve for this recreation activity or site.

On the assumption that individuals will respond to an increase in the money price of admission to a site in the same way that they are observed to respond to differences in travel cost, the area under an individual's demand curve can be taken as a measure of the value of the site or access to the activity. The aggregate value of a site or activity is simply the sum of the values all individuals place on the site. If some measure of the quality of a site is a weak complement with visits, an improvement in quality will shift the demand curve for visits out to the right. The value of the improvement in quality is the area between the two demand curves.⁴ The aggregate value of a

³For more detailed expositions of the economics of recreation demand and valuation, see McConnell (1985), Bockstael, McConnell, and Strand (1991), and Freeman (1993b). A good introduction to the contingent valuation method can be found in Carson (1991). The major treatise on CVM is Mitchell and Carson (1989).

⁴For simplicity I am here ignoring the differences between compensated and ordinary demand curves and the welfare measures that can be derived from them.

change in quality is the sum of individuals' values for the quality change.

Many authors report a consumer surplus per visit which is the aggregate value of the site divided by the sum of all individuals' visits. Consumer surplus per visit may be a useful way of summarizing information for making comparisons across studies or across sites. But consumer surplus per visit for a given level of quality cannot be used to value a change in quality that shifts the demand curve. Nor can the average value per visit be taken as a measure of the marginal value of an additional visit arising from an increase in quality..

The Random Utility Model

Rather than explaining the number of visits to a site over some interval of time, the RUM attempts to explain the choice of a site or an activity on any given choice occasion as a function of the characteristics of all of the available sites in the choice set. Since the choice of a site depends on the characteristics of that site including the cost of traveling to it, the RUM is well suited to the task of explaining the role of site characteristics in influencing the demands for visits to a site. However this capability comes at the expense of some difficulty in explaining the total number of visits to a site or the rate of participation in recreation activities.

Estimation of the RUM yields an expression for the indirect utility function:

$$v(M - t, Q, S)$$

where M is income, t is the travel cost to a site, Q is the environmental quality at a site, and S is a vector of individual characteristics. This expression can be used to calculate the consumer surplus for change in Q experienced during one visit to a site. If one of the alternatives in the

choice set was to visit no site, then this expression can also be used to estimate the-consumer surplus for one visit to the site actually chosen. This expression can also be used to estimate the value to an individual of adding or deleting sites to the choice sets.⁵

Since these expressions give welfare measures for only one choice occasion, it is necessary to find some way of predicting each individual's total number of visits per year or per recreation season. One approach is to model the determination of the number of choice occasions or activity days as a separate problem. This approach is discussed below. The second approach is an extension of the discrete choice framework to include no activity as an option for each choice occasion. There are at least a couple of ways of doing this. One is to specify that one of the alternatives is no activity and to estimate a single equation. Another alternative is to specify a nested form of random utility model in which the first equation predicts whether the individual will undertake any activity on a given choice occasion while the second gives the probability that the individual will choose a particular site or activity. The first equation would include as explanatory variables some measures of the average availability and/or quality of recreation sites accessible to the individual. The second equation would include measures of the costs and qualities of each of the available alternatives. The expected number of visits to a site is given by the product of the number of choice occasions and the joint probability of undertaking the activity and choosing that site given that some activity is chosen.

Continent Valuation Questions.

Depending upon the form of the question, the CVM technique can be used

⁵See, for example, Bockstael, McConnell, and Strand (1991).

to obtain estimates of individuals' values for one visit to a site, for access to a site for a season, or for changes in some qualitative characteristic of the site, One of the advantages of the CVM is the flexibility the approach gives to researchers to tailor the form of the question to suit the research objective.

Participation Models.

Modeling the participation of members of a population in recreation activities usually consists of two steps. In the first step, data on individuals' socio-economic characteristics and the availability and/or the quality of recreation opportunities are used to estimate an equation that gives the probability of any individual participating in the recreation activity during a year. The second stage involves predicting the number of days of recreation participation conditional upon being a participant. When these equations have been estimated for a sample of a population, they can then be used to predict the number of people participating and their levels of participation for the population as a whole. Average consumer surpluses per visit could then be used to estimate the total value to individuals of the opportunity to participate in these recreation activities. In some cases, participation models of this sort have also been used to predict changes in participation for changes in the measure of availability or quality of recreation resources. One example of this approach will be described later in this report.

It is tempting to use average consumer surplus per visit measures to calculate the value of the predicted increase participation. Several authors have succumbed to this temptation. And this practice is authorized by the U.S. Water Resources Council for the economic valuation of water resource

development projects. But this approach can be criticized on several grounds. First, it uses an average value when the marginal value for an increase in the level of the activity is relevant. Also, if the average quality of the recreation resource influences activity rates, applying a unit value only to the change in activity levels does not capture the value of a change in quality to the existing users.

Vaughan and Russell (1982) have analyzed the relationship between a "correct" welfare measure and the measure calculated by using average consumer surplus per visit. They modeled the case in which an increase in availability was interpreted as lowering the implicit price of visits to individuals. They showed that the difference between the correct measure and the measure based on average consumer surplus could be quite large. And even the sign of the difference depended upon the functional form of the demand function.

In conclusion, participation models may be useful in helping to determine which qualitative characteristics of recreation sites influence recreation participation rates. But we do not have a reliable basis for calculating the welfare effects of changes in these measures of availability.

III. THE VALUES OF MARINE RECREATION ACTIVITIES AND SITES

Many of the studies reviewed for this report provide estimates of the total value for specific recreation activities or the total value of access to a site or set of sites. Many of these studies also provide measures of the values of changes in qualitative characteristics of these sites. The results on the values of characteristics are presented in Section IV. The results of studies of site or access values are summarized in this section for two groups of activities: fishing, and beach use including swimming. All of the value

measures presented in this report have been converted to 1991 dollars by using the Consumer Price Index.

Marine Fishing

There can be no doubt that marine recreational fishing is an economically significant activity. On the basis of data from the Marine Recreational Fisheries Statistics Survey, we can state that approximately 10 million people participate in this activity in a typical year and the total number of trips is in the range of 50 million per year. About three-quarters of this activity takes place along the Atlantic and Gulf coasts with the **remainder being on the Pacific Coast⁶**

The category of marine recreational fishing covers a wide range of activities. Fishing activities can be categorized by the nature of the waters (for example, open ocean versus estuary), by mode (for example, fishing from shore versus using a boat), by target species, and by whether the fishing is done by individuals or small groups acting separately or is organized through commercial party boats and charter boats. Furthermore, there is substantial variation across studies in the way in which the geographic extent of a fishery is defined. Some studies measure the value of access to the whole coastline of a state while others focus on access to more limited areas such as a river or bay, the coastline of a county, or a single port. Finally, studies vary in the way that they define the extent of the market, that is, the geographic area and population from which potential users of the fishery are drawn. Some studies provide estimates of values for all users of the fishery, while others focus on users within a particular state or, in one

⁶See U.S. Department of Commerce (1985) and (1990), and U.S. Department of Interior (1992).

case, a county. All of this makes summarizing results and making comparisons across studies somewhat difficult.

The study with the broadest geographic scope and extent of the market is Vaughan and Russell (1985). This study estimated the increases in marine recreational fishing at the coasts and on the Great Lakes that would follow from full implementation of the 1972 Clean Water Act effluent standards. The maintained hypothesis was that meeting effluent standards would increase the availability of unpolluted shoreline for anglers. Most of the increase in participation was predicted to occur on the Great Lakes, rather than at the coasts. This is at least in part attributable to the relatively small increase in availability of unpolluted coastal shoreline. This study did not attempt to estimate the value of the increase in angling. Rather it calculated monetary benefits by using unit values for fishing days derived from another study (Charbonneau and Hay, 1978).

I have found 22 studies that provide estimates of the value of access to a fishery where the fishery is defined by some combination of species and geographic area. Five of the studies present estimates of the consumer surplus per person per year. Seven of studies estimate consumer surplus per trip. And 10 of the studies either present separate estimates of both trip and per year consumer surplus or include enough information so that both can be calculated by the reader. Eleven studies present estimates of the value of access to fishing for a single species.⁷ These studies cover six different species, striped bass on the Atlantic coast, red drum, atlantic salmon, king mackerel, and pacific salmon (five studies). The remainder of the studies

⁷In one case involving San Francisco Bay (Huppert, 1989), the species is "anadromous" fish, where striped bass and salmon are treated together as one species.

present estimates for all species together or for groups of species, for example, big game fish, small game fish, or bottom fish.

Most of the studies producing estimates of values of access to a single species fishery did so by restricting their samples to anglers who targeted the species of interest. Four of the studies sampled all anglers and included catch rate or species abundance data for specific species as arguments in the travel cost function or indirect utility function. These studies were then able to calculate welfare losses for reducing the catch rate of the species in question to zero. Studies employing this approach to obtaining species specific data are Cameron (1989), Morey, Shaw, and Rowe (1991), Rowe, et. al. (1985), and Wegge, Carson, and Hanemann (1988).

The economic method most commonly employed in these studies is some variation of the standard travel cost model. The second most common approach is the single equation random utility model. There are four studies based on the nested random utility model. Several studies provide estimates based on different methods or models for purposes of comparison. Several studies also present estimates for various subsets of their sample, or estimates based on different model specification and statistical estimation techniques.

Table 1 displays values per trip for access to single species fisheries; and Table 2 displays values per trip for access to multi-species fisheries. Within species groups, studies and their values are listed approximately in the order of the size of the reported values (highest values first).

The most striking feature of these two tables is the wide range of values reported. Values per trip for single species fisheries range from \$4.44 to \$346, a range spanning almost two orders of magnitude. Values per trip for all species range from a low of \$0.97 to a high of \$799, a range of

Table 1. Values per Trip for Access to a Single Specks Fishery (in 1991 dollars)

<u>Species and Author</u>	<u>Method^a</u>	<u>Geographic Extent of Market^b</u>	<u>Site^c</u>	<u>Value Per Trip</u>
<u>Striped Bass</u> Norton, et. al. (1983)	TC	Not specified ^d Not specified ^d	Chesapeake Mid Atlantic	\$64 \$279
<u>Red Drum</u> Cameron (1992)	Joint	Texas	Texas Coast	\$91
<u>Atlantic Salmon</u> Morey, Rowe, and Watson (1991)	RUM	Maine	Penobscot River	\$96 (Mean) \$83 (Median)
<u>King Mackerel</u> LeeWorthy (1990)	TC	Not Specified ^e	Florida	\$56.40
<u>Pacific Salmon</u> Wegge, et. al.. (1988)	NRUM	Alaska	Deep Creek, AK	\$48.50
Cameron (1988a)	RefCVM	Not specified ^d	British Columbia	\$34.22
Rowe, et al. (1985)	Rum	Not specified ^d Not specified ^d Not specified ^d	California Oregon Washington	\$7.43 \$6.00 \$0.44
<u>Striped Bass and Salmon</u> Huppert (1989)	TC	San Francisco Bay Area	San Francisco Bay	\$346 (OLS) ^e \$170 (MLLS) ^f \$77 (ML) ^g

Notes

^aRUM = Random utility model
^aNRUM = Nested random utility model
^aTC = Travel cost model
^aRefCVM = Referendum contingent valuation method
^aJoint = Joint Travel cost/referendum CVM

^bArea of residences of anglers in sample

^cArea of access to fishery

^dSample is not restricted as to area of residence

^eEstimated by ordinary least squares

^fEstimated by non-linear least squares

^gEstimated by maximum likelihood

Table 2. Values per Trip for Access to a Multi-Species Fishery (in 1991 dollars)

<u>Region and Author</u>	<u>Method^a</u>	<u>Geographic Extent of Market^b</u>	<u>Site^c</u>	<u>Value Per Trip</u>	
<u>Pacific Coast</u>					
Wegge, et. al. (1986) ^d	TC	Southern California	Southern California	Charter boat-day trip	
				Boat owners	\$30 to 125
				Do not own boat	\$67 to 253
				Charter boat-more than 1 day	
				Boat owners	\$70 to 501
				Do not own boat	\$86 to 799
	CV	Southern California	Southern California	Private boat	\$84 to 373
				Shore-boat owners	\$47 to 237
				Charter and party boats	\$79 (mean) \$31 (median)
				Rental boat	\$24 (mean) \$21 (median)
				Private Boat	\$73 (mean) \$41 (median)
				Shore	\$16 (mean) \$10 (median)
<u>Atlantic and Gulf Coast</u>					
Cameron (1992)	Joint	Texas	Texas		\$238
Arnsdorfer and Bockstael (no date)	TC	Not specified ^e	NW Florida	Charter boat	\$222 to 770 ^f
Bell, et. al. (1982)	CVM	Rest of Country Florida	Florida Florida		\$45 \$58
Bockstael, et. al. (1989b)	NRUM	Not specified ^d	Palm Beach County Bevard County		\$9.53 ^g \$0.97 ^g
Kaoru and Smith (1990)	RUM	North Carolina	Most popular site on NC sounds		\$23.90 to 39.11 ^h \$4.30 to 7.77 ⁱ
Kaoru (1991)	NRUM	North Carolina	Albermarle Sound Most popular site		\$3.09 \$1.97
Agnello and Han (1992)	TC-VP	Long Island	Long Island		\$23.84

Notes ^aRUM = Random utility model
TC-VP = Varying parameters travel cost model
CVM = Contingent valuation method
NRUM = Nested random utility model
TC = Travel cost model
RefCVM = Referendum contingent valuation method
Joint = Joint Travel cost/referendum CVM

^bArea of residences of anglers in sample

^cArea of access to fishery

^dRange reflects two different model specifications.

^eSample is not restricted as to area of residence

^fRange depending on charter trip length and whether sample omits anglers traveling by bus

^gValues per choice occasion where one option is not fishing

^hActual sites aggregated to 11 clusters. Range reflects differences in water quality measures used as independent variables

ⁱRange reflects differences in site aggregation and water quality measures

almost three orders of magnitude.

It is also interesting to note the wide range in values per trip found by Huppert (1989) depending on the statistical model used for estimation. The reported values differ by almost a factor of five. Huppert discusses some of the statistical issues involved in model selection. But he cannot find a basis for preferring one model over the others on statistical grounds.

Other than the higher values from Huppert and the travel cost values from Wegge, Hanemann, and Strand (1986), most of the reported values in the two tables fall in the range of \$10 to \$100 per trip. The high value for striped bass fishing in the mid-Atlantic states (Norton, et. al., 1983) is plausible, since anglers have the opportunity to catch very large fish (20 pounds and up). Striped bass anglers are among the most avid of recreational anglers (Cole, 1978). Similarly, the high values reported in the pilot study by Arnsdorfer and Bockstael (no date) may reflect the high quality of the charter boat fishing experience in the Gulf of Mexico.

The low values for salmon reported by Rowe, et. al. (1985) are puzzling, especially given the results of the other two studies of salmon reported in Table 1.⁸ The low values reported by Kaoru and Smith (1990) and Kaoru (1991) may be at least in part explainable by the nature of the problem they are analyzing. Both studies utilize a data set for 35 sites (boat landings, marinas and so forth) on Albermarle and Pamlico Sounds in North Carolina. The lowest values reported are for access to just one of the sites, while other sites are still available. Kaoru and Smith also aggregate sites into clusters. When they aggregate to only 11 "sites", the value of access to one

⁸See also the entry for Bergland and Brown (1988) and Loomis (1988) reported in Tables 3 and 5 respectively.

of those sites is substantially increased, to the range of \$24 to \$39, depending upon model specification. This indicates the importance of the availability of substitute sites in determining the calculated value of access to any one site. In Kaoru (1991), however, the welfare loss associated with losing access to all of the sites on Albermarle Sound is only \$3.09. This low value of access is puzzling.

The study by Wegge, Hanemann, and Strand (1986) presents an opportunity to compare access values derived by two different methods from the same sample. This study was based on responses to a mail survey of anglers in Southern California. In addition to obtaining travel cost and related data, respondents were asked a set of contingent valuation questions for four different modes of fishing, by charter and party boat, by rental boat, by private boat, and from the shore. For each mode that an angler participated in, the angler was asked a bidding game question of the following form: "If the cost of your trip increased by \$X per trip would you stop taking this form of trip altogether?" If the response was no, the question was repeated with higher values. Depending upon the mode, there were an additional four to six iterations with the cost, increasing by a factor of 12 to 40 for the last question. This study reported both the mean and median values of the highest price at which fishing would continue.⁹

The responses derived from the contingent valuation question are substantially lower than those calculated from the travel cost models. The pattern of responses to the contingent valuation question across modes is

⁹Since some respondents indicated no cutoff price in the range of prices on the survey instrument, the authors presented means calculated on the basis of assuming the true highest price was either 20 percent or 50 percent above the highest price asked. The values reported in Table 2 are based on the 20 percent assumption.

plausible. Charter and party boat and private boat fishing are more highly valued than rental boat and shore fishing trips.

Tables 3 and 4 report values of access per person per year to single species and multi-species fisheries respectively. These tables add some additional information since there are five studies that report only access values per year. Again the range of estimated values is striking. However, there are only two studies reporting values that are less than \$100 per year. At least one of these is easily explainable. Milon (1988b) estimated the value of adding an artificial reef in a region in which there were already seven such reefs. The reported values may simply reflect the low marginal value of an additional reef. There is one other notable aspect of the Milon Study . This is the sensitivity of the value estimate to the model selected for the analysis. Values for the travel cost model and the nested random utility model differ by a factor of ten.

The study by Morey, Shaw, and Rowe (1991) utilized a subset of the sample data in Rowe, et. al. (1985). That study reported a very low value per trip for access for salmon fishing in California, Oregon, and Washington. Morey, Shaw, and Rowe utilized a form of random utility model to calculate the annual value of access to salmon in Clatsop County on north coast of Oregon. The annual value of access to this fishery for residents of Clatsop County was five times higher than the annual value to residents of Deschutes County in the middle part of the state. This relationship is plausible on a priori grounds. The overall low values per year found in this study may be explained, at least in part, by the fact that the study was based on a sample of all licensed anglers, not just those targeting salmon.

Table 3. Values per Person for One Year's Access to a Single Species Fishery (in 1991 dollars)

<u>Species and Author</u>	<u>Method^a</u>	<u>Geographic Extent of Market^b</u>	<u>Site^c</u>	<u>Value Per Year</u>
<u>Red Drum</u>				
Cameron (1992)	Joint	Texas	Texas Coast	\$1,569
<u>King Mackerel</u>				
Leeworthy (1990)	TC	Not specified ^c	Florida	\$1,376
<u>Flounder</u>				
McConnell (1979)	T C HP	Rhode Island Rhode Island	Rhode Island Rhode Island	\$524 \$1,169
<u>Atlantic Salmon</u>				
Morey, Rowe, and Watson (1991)	RUM	Maine	Penobscot River	\$932 (mean) \$572 (median)
<u>Pacific Salmon</u>				
Bergland and Brown (1988)	NRUM	Not specified ^d	One port in Oregon ^e	\$350
Morey, Shaw, and Rowe (1991)	RUM	Clatsop Cty, OR Deschutes Cty, OR	Clatsop Cty, OR Deschutes Cty, OR	\$2.52 \$0.51
<u>Striped Bass and Salmon</u>				
Huppert (1989)	TC	San Francisco Bay Area	San Francisco Bay	\$2,331 (OLS) ^f \$1,054 (MLLS) ^g \$477 (ML) ^h

Notes

^aRUM = Random utility model
 HP = Household production model
 NRUM = Nested random utility model
 TC = Travel cost model
 Joint = Joint Travel cost/referendum CVM

^bArea of residences of anglers in sample

^cArea of access to fishery

^dSample is not restricted as to area of residence

^eBrookings, OR, on the Oregon coast just north of the California border

^fEstimated by ordinary least squares

^gEstimated by non-linear least squares

^hEstimated by maximum likelihood

Table 4. Values per Person for One Year's Access to a Multi-Species Fishery (in 1991 dollars)

<u>Region and Author</u>	<u>Method^a</u>	<u>Geographic Extent of Market^b</u>	<u>Site^c</u>	<u>Value Per Year</u>	
<u>Pacific Coast</u>					
Wegge, et. al. (1986)	TC	Southern California	Southern California	Charter boat-day trip	
				Boat owners	\$463
				Do not own boat	\$936
				Charter boat-more than 1 day	
				Boat owners	\$1,855
				Do not own boat	\$2,954
				Private boat	\$4,261
			Shore-boat owners	\$1,697	
<u>Atlantic and Gulf Coast</u>					
Cameron (1992)	Joint	Texas	Texas		\$4,141
Kahn (1991)	TC	New York	Long Island Long Island	Charter boat Party boat	\$440 \$1,200
Bell, et. al. (1982)	CVM	Rest of Country	Florida Florida	Florida	\$1,115 \$243
Arnsdorfer and Bockstael (no date)	TC	Not Specified ^d	NW Florida	Charter boat	\$399 to 1,387 ^d
McConnell, et. al. (1992)	RefCVM	Atlantic Coast (NY-FL)	Atlantic Coast (NY-FL)		\$755 to 872 ^e
Agnello and Han (1992)	TC-VP	Long Island	Long Island		\$372
Milon (1988b)	NRUM	Florida	Reef		\$2.29
		RUM	Florida	Reef	\$7.81
		TC	Florida	Reef	\$23.85

Notes

^aRUM = Random utility model
^bCVM = Contingent valuation method
^cNRUM = Nested random utility model
^dTC = Travel cost model
^eRefCV = Referendum contingent valuation method
^fJoint = Joint Travel cost/referendum CVM

^bArea of residences of anglers in sample

^cArea of access to fishery

^dSample is not restricted as to area of residence

^eRange reflects variation across states (NC-NY)

Summary

On the basis of the studies reviewed in this section, one can conclude that there are significant economic values associated with access to marine recreational fishing sites. On a per trip basis, these values are most likely to lie in the range of \$10 to \$100 depending upon the species, location, etc. Annual values per person are most likely to lie in the range of \$100 to \$1,000, again depending upon species, location, etc. These economic values will vary according to:

- the geographic extent of the market included in the study;
- the species available at the site; and
- the size and location of the fishing site.

I hypothesize that, other things equal, as the geographic extent of the market is expanded in any study, the average value per person or per trip will decline. This is because as the sampling frame is expanded to capture more people, the additional anglers are more likely to have substitute fresh water or marine sites closer to home, and for that reason to place a lower value on the site in question. I also hypothesize that other things equal, the value of access for all species together will be greater than the value of access to a single species. Finally, I hypothesize that, holding other things equal, expanding the geographic extent of the site being valued will result in a higher value per trip or per person. For example, the value of access to the shoreline of one state will be larger than the value of access to one county in that state. This is because in the latter case, the rest of the state's shoreline is available as a substitute.

It must be emphasized that virtually none of these hypotheses can be tested using the data available from these four tables. This is because the

"holding other things constant" condition is not satisfied when the values from most of these studies are compared.

Beaches and Swimming.

I have found only four studies of the economic value associated with beach activities. Bell and Leeworthy (1990) treated all the coastal beaches in Florida as a single site and estimated the average consumer surplus per person for all out of state tourists who visited beaches. The average consumer surplus per person was \$235. When this figure is divided by the average number of beach days per person, the resulting consumer surplus per visit is \$50.40. The principal problem with this study is that the implicit price of a beach day, given that one has traveled to Florida, is an endogenous variable since it depends on the location of the hotel/motel the visitor chooses, the price of the motel, and the chosen level of spending on food, etc.

Leeworthy (1991) conducted a travel cost study of visitors to a state park and reef in Florida. The author reported consumer surplus per person per day. The summary data indicate that there was substantial variation in the number of days per visit across the sample. Reported consumer surplus per person per day varied widely according to model specification. The range was from \$223 to \$3,448. These figures also seem high. But apparently this park and reef is a unique resource.

Leeworthy and Wiley (1991) report consumer surplus per person per day for visitors to a state park on the New Jersey coast. The summary data indicate that virtually all of the people in the sample were day trippers. Consumer surplus per day or (approximately) per visit ranged from \$24.74 to \$88.17 depending on functional form and the treatment of regression

uncertainty in calculating the consumer surplus measure.

Finally, Silberman and Klock (1988) used a contingent valuation bidding game format to obtain per day values for visitors to a stretch of ocean beach along the northern end of the New Jersey shore. They obtained a mean bid per day of \$4.57. There are at least two possible explanations for these low values in comparison with those of Leeworthy and Wiley (1991). First, the beaches studied by Silberman and Klock maybe of lower quality. Apparently some of these beaches are presently suffering from erosion and are candidates for beach re-nourishment projects. And second, there may be an anchoring bias in the responses to the CVM questions, since the payment vehicle utilized in this study was an increase in the price of admission to the beach.

Summary

In this section I have reviewed those studies that can help to answer the first question posed in the introduction, "What does the literature tell us about the economic values that people place on access to marine related recreation activities and sites?" I have found an extensive literature with quantitative estimates of the value of access to marine recreational fishing. I have found very limited literature on the value of access to beaches for activities such as swimming and sunbathing. And there is virtually no literature that I have found on the value of access to marine waters for boating activities other than fishing. The lack of attention to the latter forms of marine recreational activity is somewhat puzzling for two reasons. The first is the evidently high levels of participation in both of these forms of recreational activity. The second is that there are important economic and public policy issues surrounding both of these activities. For example, investments in beach protection and beach enhancement may be quite costly.

But they cannot be evaluated on economic grounds without some estimates of the benefits in the form of preserved or enhanced access to beach activities. Governments also play a role in the provision of access to marine boating. For example, public access can take the form of boat launching ramps, public docks, and the leasing of publicly owned submerged lands for marinas and other boating support activities. My review has uncovered a need for more economic research into the values created by such public activities.

IV. INCORPORATING QUALITY ATTRIBUTES

In this section I review the results of those studies of marine recreational fishing, beach use, and boating that include estimates of economic value of changes in some qualitative attribute or characteristic of the resource or site at which the activity takes place.

Fishing

The first question to be addressed is how to define and measure the qualitative characteristics of the fishery resource that are hypothesized to affect individuals' values for the resource. All of the studies discussed in this section have employed some measure of the abundance of fish in the water or the number of fish caught, either of which reflect at least in part the likelihood the angler would catch a fish and consider the trip a success. Three studies have also included some measure of water quality that might be affected by EPA water pollution control policies. The results of including water quality variables will be discussed later in this section.

One study (Cameron, 1992) was significant in that it utilized an objective measure of fish abundance drawn from periodic gill net samples in the relevant waters. It is interesting that this study also resulted in one

of the highest values for a change in abundance. The other studies utilized one of three different possible forms of catch rate variables. One form is to use each individual's catch per trip or catch per unit of time as a measure of abundance of fish. The individual's catch rate can be measured separately for each trip or averaged over something like a season. The former measure is likely to include a substantial random component that is at least partly evened out in the average individual catch rate measure. But all individual catch rate measures suffer from the likelihood of incorporating confounding individual characteristics such as fishing knowledge and skill and endowment of fishing capital (equipment). On the other hand, the individual's own catch rate at any given site is probably that individual's best information about abundance at that site. In other words, the individual may not have good information on average catch rates or other measures of abundance at any site.

The second form of measure is an average of all anglers' catch at each site. This measure averages out the individual variation referred to above. However, information on average catch rates may not be widely distributed to anglers and, therefore, may not have that strong an influence on anglers' behavior.

The third form of catch rate variable takes advantage of both individual characteristics and average catch rates as a measure of abundance. This approach is attributable to McConnell, et. al. (1992). These authors construct an individual catch rate that is a random variable depending on the density of fish at the site as estimated from historic average catch rates and individual characteristics such as experience, mode of fishing (party boat, private boat, etc.), experience, and hours fished.

Twenty-seven of the studies reviewed for this report incorporated some

measure of catch rate or abundance. In all but three of these studies, the catch rate variable was positive and significant, at least in most of the model specifications. The exceptions are Cameron (1988b), Kahn (1991), and Milan (1993).

The most commonly used method for incorporating a quality measure was some form of travel cost model. Several variations of the basic travel cost technique were employed, including pooled and multi-site models, varying parameter models, and the hedonic travel cost model. The remainder of the studies utilized either some form of contingent valuation question or some form of random utility model.

Most of the studies computed welfare changes for some postulated change in the catch rate variable, for example, a 50% increase, or an increase of one fish per trip. Cameron and James (1987) and Cameron (1988) also estimated the value of increases in the weight of fish caught. Selected results from those studies focussing on the number of fish are tabulated in Table 5. Some of these studies also calculated welfare losses associated with reductions in catch rate. The welfare measure usually calculated was either the compensating variation for the choice occasion (trip) as computed from the conditional indirect utility function of the random utility model or was the area between the two travel cost demand curves in the travel cost model. Dividing the latter measure by the number of trips taken at the existing quality level yields a value per trip for the increase in quality. This is a useful summary measure for making comparisons across studies.

The highest value reported in Table 5 is \$122 for a 50 percent increase in the catch of king mackerel off the east coast of Florida (Leeworthy, 1990). The majority of reported values are under \$20 per trip. And the nested random

Table 5. Values per Trip for Increases in Catch Rates (in 1991 dollars)

<u>Author</u>	<u>Species</u>	<u>Method^a</u>	<u>Region/Site</u>	<u>Increases in Catch^b</u>			
				<u>100%</u>	<u>50%</u>	<u>20-25%</u>	<u>One fish per trip</u>
Leeworthy (1990)	King Mackerel	TC	Florida - East coast		\$122		
Huppert (1989)	Salmon and Striped Bass	TC	San Francisco Bay	\$90 ^c (1.36)			
Morey, Rowe and Watson (1991)	Atlantic Salmon	RUM	Penobscot River	\$60 (mean) \$66 (median) (.1)			
Cameron (1992)	Red Drum	Joint	Texas		\$88		
Loomis (1988)	Salmon	TC	Oregon Coast				\$28 to 85 ^d
Leeworthy (1990)	King Mackerel	TC	Florida -West Coast		\$45		
Huppert (1989)	Salmon and Striped Bass	TC	San Francisco Bay	\$33 ^e			
Loomis (1988)	Salmon	TC	Oregon Rivers				\$9.80 to 23.38 ^f
Norton, et. al. (1983)	Striped Bass	TC	New England				\$20.84 (.54)
Rowe, et.al. (1985)	Salmon	RUM	Washington ^g	\$19.58			
Cameron and James (1987)	Chinook Salmon	RefCVM	British Columbia				\$18.46 (.5)
Rowe, et.al. (1985)	Salmon	RUM	Oregon ^g				\$16.68
Milon (1988c)	King Mackerel	RUM	Gulf Coast			\$13.43	
Kaoru and Smith (1990)	All	RUM	Pamlico and Albermarle Sounds			\$11.07 ^h	
Huppert (1989)	Salmon and Striped Bass	CVM	San Francisco Bay	\$8.35			
Rowe, et.al. (1985)	Salmon	RUM	California ^g				\$8.20
Kaoru and Smith (1990)	All	RUM	Pamlico and Albermarle Sounds			\$7.09 ⁱ	
Agnello and Han (1992)	All	TC-VP	Long Island	\$5.95 (5)			
Cameron (1988a)	Salmon	RefCVM	Victoria, B.C.				\$3.13 (1)

Table 5. (continued) Values per Trip for Increases in Catch Rates (in 1991 dollars)

Author	Species	Method ^a	Region/Site	Increases in Catch ^b			
				100%	50%	20-25%	One fish per trip
Norton, et.al. (1982)	Striped Bass	TC	South Atlantic				\$2.21
Bockstael, et.al. (1989b)	Big Game ^j	NRUM	Florida			\$1.87	
	Bottom Fish ^j	NRUM	Florida			\$1.52	
Agnello and Han (1992)	All	TC-VP	Long Island			\$1.31 (5)	
Smith, et.al. (1991)	All	HTC	Pamlico and Albermarle Sounds		\$0.70 to 1.28 ^k (1.64 per hour)		
Bockstael, et.al. (1989b)	Small Game ^j	NRUM	Florida			\$0.40	
Bockstael, et.al. (1989b)	Non-target ^l	NRUM	Florida			\$0.38	
Kaoru (1991)	All	NRUM	Pamlico and Albermarle sounds			\$0.25	

Notes

^aNRUM = Nested random utility model
 TC-VP = Varying parameters travel cost model
 CVM = Contingent valuation method
 NRUM = Nested random utility model
 TC = Travel cost model
 HTC = Hedonic travel cost model

^bWhere available, the baseline catch rate is reported in parenthesis.

^cThis is an exact welfare measure based on the indirect utility function recovered from the travel cost demand model.

^dRange of values for 8 ports on the Oregon and Washington coast.

^eEstimated ordinary consumer surplus based on maximum likelihood estimate of travel cost demand function.

^fRange of values for 3 rivers in Oregon.

^gThe study reports values by county. The value reported here is the median of all coastal counties in the state.

^hHighest of range of alternative specifications

ⁱLowest of range of alternative specifications

^jSample limited to anglers targeting this species group.

^kThe range for both bank and boat fishers and two different values for time. The percentage increase in catch was 61%.

^lSample consists of anglers who do not state a target species.

utility models for Florida (Bockstael, et. al., 1989b) and the North Carolina Sounds (Kaoru, 1991) yield values of under \$1.00 per trip.

There are five studies that report values of increased catch in dollars per year rather than per trip. By far the highest annual value for increased catch is for king mackerel reported by Milon (1991). Using a pooled travel cost model, Milon estimated annual values for three alternative measures of catch: total catch, kept catch, and released catch. Annual values for a 25% increase ranged from a low of \$61 per year for an increase in the kept catch rate to a high of \$99 per year for an increase in the released catch rate.

The other studies reported lower annual values for increased catch. Morey, Shaw, and Rowe (1991) calculated the value of an increase of one salmon caught per trip to Clatsop County in Oregon at \$1.58 per person per year for residents of Clatsop County and \$0.20 per person per year for residents of Deschutes County in Oregon. The most likely explanation for these low annual values is that the sample was drawn from all licensed anglers rather than those targeting salmon.

Two contingent valuation studies of the value of increased catch also showed low values per year per person. Milon et al., (1993) used an open-ended contingent valuation question to obtain values for a variety of changes in management practices for six species in Florida where the management practice was expected to lead to an increase in average catch per trip. Annual values in the range of \$1 to \$2 were found for improvements that ranged from 50% to 200%. The species covered were king mackerel, seatrout, and redfish. Again, one possible explanation for the low mean values is the inclusion in the sample of anglers who do not fish for the species in question.

McConnell, et. al., (1992) used data from a referendum CVM to value one more fish for several target species groups. They find that the value of one more big game fish is \$9.50 per person per year in Florida and \$1.54 per person per year in Virginia. The difference could be due to differences in the predominant big game species in the two states. One more small game fish per trip in Georgia is valued at \$1.96 per person per year and at only \$0.34 per person per year in Virginia. Although these values seem to be small, the coefficients on the catch rate variables in the estimated equations are highly significant.

Agnello (1989) estimated travel cost demand functions for three species and used them to calculate two kinds of per fish value, the value of the first fish caught and the value the average fish caught (consumer surplus divided by total of number of fish caught). For summer flounder, the value of the first (average) fish was \$21.28 (\$11.09). For weak fish, the value of the first (average) fish was \$17.9 (\$12.15). Finally, for bluefish, the value of the first (average) fish was \$6.85 (\$1.63).

Adding Water Quality Variables. In her analysis of referendum CVM responses, Cameron (1988b) found that although total catch of each respondent was positive in predicting the probability of a yes response, it was not statistically significant. She then added six water quality variables. Three entered with positive and significant coefficients. They were non-filterable residues, phosphorus, and chlorophyll-A. These variables are difficult to interpret as water quality measures. Specifically, phosphorus and chlorophyll-A, as indicators of nutrient levels, might be negatively related to value in areas experiencing excess nutrients. Two measures of metals in sediments (chrome and lead) were negative but not significant.

Kaoru and Smith (1990) and Kaoru (1991) experimented with alternative proxies for measures of water quality in their study of the North Carolina Sounds. One set of variables was meant to capture excess nutrients. These variables were estimates of nitrogen and phosphorus loadings by adjacent county. When these variables were entered along with the catch rate variable, nitrogen was negative and highly significant; but phosphorus was positive and highly significant. These variables may be proxies for some other aspect of water quality or site characteristics. As an alternative, these two studies also computed biochemical oxygen demand (BOD) and total suspended solids (TSS) from data on flows and loadings through municipal waste water treatment plants. When BOD and TSS were used as water quality measures, they sometimes had the wrong sign, but usually were not significant.

Summary. The studies reviewed here provide strong evidence that fishing success is an important characteristic and influences the behavior of individuals. This finding is robust across different data sets, model specifications, and estimation methods. Changes in fishing success are significant predictors of changes in use. Changes in individuals' behavior in response to changes in success can be used in appropriate models to calculate welfare measures. These welfare measures are often large percentages of the access values for the same fishery. For example, Morey, Rowe, and Watson (1991) found that the value of a 100 percent increase in the catch rate for atlantic salmon was almost as large as the access value to that fishery at the current catch rate. The results of Cameron (1992) for red drum show a similar relationship between present access value and the value of a 50 percent increase in species abundance. Thus if water quality improvements lead to increases in catch rates, the benefits to users of these fisheries could be

substantial.

Beach Use including Swimming.

Considering the number of people who visit beaches and other activities, it is surprising how few studies have focused on the demand for beach use and, in particular, the role of qualitative attributes of beaches in explaining the demand for beach visits and the value of access to beaches. In this section I summarize results of six analyses of beach use and the values of measures of **beach quality**.¹⁰

Vaughan, et al. , (1985) attempted to use a participation model to determine how participation in swimming at marine beaches was influenced by the availability of unpolluted beaches. But in their statistical analysis, they could not detect a significant and robust effect of quality or availability on beach use. Their tentative explanation was that the beach quality data were not good enough for this purpose.

Feenberg and Mills (1980) and Bockstael, Hanemann, and Kling (1987) have both conducted studies based on data from a household survey of beach users in Boston. Both studies utilized a RUM to calculate benefits per trip and per person for a season for reductions in water pollutants such as oil, total bacteria, color, and chemical oxygen demand. The results show quite small benefits per trip ranging from a few cents to a little over \$1 depending upon the attribute and the magnitude of the change. The results are quite comparable in the two studies. Even small benefits per trip add up over a season when an individual may make a number of trips. The closest comparison between reported results of the two studies is for a 10 percent reduction in

¹⁰McConnell's (1977) analysis of the willingness to pay to avoid congestion is not directly relevant to this study.

oil, total bacteria, and color (Feenberg and Mills) versus the same percentage reduction in oil, fecal coliform bacteria, and chemical oxygen demand (Bockstael, Hanemann, and Kling). Feenberg and Mills found a value of \$3.23 per person per year for their change, while Bockstael, Hanemann, and Kling found a value of \$10.48 for their change. This comparison demonstrates that different analyses and methods of computing welfare changes from the same underlying data set can lead to different results.

McConnell's (1986) study of the damages to beach users in New Bedford yielded damages per household in the range of \$3-4 per year. As in the case of the two Boston studies, these are beaches in urban areas that are used primarily by local residents for trips of 1 day or less in duration. And the annual values per person are the same order of magnitude. However the quality differences being valued were quite different in the two studies. The quality parameters valued in the Boston studies were changes in presumably perceptible attributes of water quality, whereas in the New Bedford case, respondents' knowledge of the pollution came only from news media reports of the finding of PCBs in bottom sediments. Also the Boston values were based on observed behavior, while the New Bedford study was based on responses to a question about hypothetical behavior.

Bockstael, McConnell and Strand (1989a) provided two independent estimates of the value of water quality in beach use or swimming in the Chesapeake Bay. The travel cost model of beach visitors, when aggregated over all visitors, yielded a total value for a 20 percent improvement in water quality of about \$45 million. The contingent valuation question about improving presently unacceptable water to acceptable for swimming, when aggregated over the population of the Washington and Baltimore SMSAs yielded a

total value of about \$89 million. The two values are not strictly comparable both because they are aggregated over different populations and because they value different changes in water quality. Arguably, a change from unacceptable to acceptable is larger than a 20 percent improvement in measured water quality for people who are already using a beach. Although, the CV question referred to acceptability for swimming, respondents may have also been valuing other possible uses made possible by the improved quality.

In summary, if disaggregate data on specific beaches are available, it is possible to identify characteristics of beaches that affect behavior and that have value. Given the large numbers of visits to beaches, small values per person could result in large aggregate values for changes in important beach characteristics.

Boating.

I have found only two studies attempting to link the demand for and value of marine boating activity to changes in water quality. Vaughan, et al., (1985) analyzed national boating participation and boat ownership data and linked this to the availability of unpolluted marine waters. The authors did not find significant benefits associated with improvements in marine water quality. This is at least in part because of the poor quality of the water quality data available for their study and in part because of the small predicted impact of the Clean Water Act on marine water quality at the national level.

Bockstael, McConnell, and Strand (1989a) focused on one area, the Chesapeake Bay, and used revealed behavior in response to measured differences in nutrient concentrations (nitrogen and phosphorous). Excessive nutrients are believed to be responsible for changes in submerged aquatic vegetation and

turbidity that may affect the amenity values associated with boating activities. For one group of boaters, those who trailer their boat to an access point, the authors found benefits for a 20 percent improvement in the water quality measure of about \$78 per boater. **Thus**, in those areas where there are perceptible water quality problems, there may be significant values associated with improving water quality.

Summary.

The second set of questions posed in the introduction is, "What attributes of recreation sites matter to people? And what values do they place on changes in the attributes?" For recreational anglers, the primary attribute that matters is fishing success as measured either by catch rate or abundance of the target species. There is very little evidence that water quality variables play any independent role in influencing behavior and the values that people place on marine recreational fishing. There is also evidence that people place different values on increasing abundance of different species. At this point, it is not clear how much of the observed variation in values across species is due to differences in model specification and estimation and how much reflects true differences in individual preferences. The substantial variation in values within a species group suggests that model specification and estimation may play an important role in explaining differences in values across studies, as well.

For beaches, the available evidence suggest that perceptible pollutants such as oil and potential threats to health such as fecal coliform bacteria and PCB contamination are important attributes. The values per person per day for changes in these attributes may be relatively small. But given high participation in beach activities, aggregate values can be large.

For boating, there is only a limited body of evidence. But the study by Bockstael, McConnell, and Strand (1989a) suggests that there may be important benefits in cleaning up perceptible pollution problems in some water bodies such as Chesapeake Bay.

V. LINKING VALUES TO POLICY

In order to use the results of the studies reviewed in this report to evaluate water pollution control policies, it is necessary to establish the links between the discharges or loadings of pollutants affected by these policies and the attributes of the recreation resources that matter to people. In the cases of beach use and boating, these links may be relatively easy to establish, at least for some attributes and pollutants, for example fecal coliform bacteria. But there are relatively few studies of the value of beach use and the value of reducing pollution at beaches.

In the case of recreational fishing, establishing these links appears to much more difficult. First, there are only two sets of economic studies that have reported the results of including water quality or water pollution measures when estimating demand and value functions. And results of these two studies have been mixed in terms of the expected signs of these variables and **their statistical significance.**¹¹ Second, all but one of the remaining studies were based on catch or success rates rather than stock abundance, per se. It is reasonable to assume that catch rate is positively linked to stock abundance. But it would be useful to have this relationship confirmed empirically and to have some information on the shape of the relationship. For example, is it a simple linear relationship? Is it a constant elasticity

¹¹See Cameron (1988b), Kaoru and Smith (1990) and Kaoru (1991).

relationship?

Third, only one of the studies reviewed here used a measure of stock abundance. Cameron (1992) found that abundance of red drum as measured by gill net surveys was positive and significant in explaining anglers' values for this fishery. But this still leaves us with the question of the relationship between water quality and abundance.

I have found only one major study of this relationship for species of commercial and recreational significance. Summers et al. (1987) estimated the relationships between constructed measures of stock abundance and various hydrographic and "macropollution" variables for 24 species in each of five Atlantic Coast estuaries. The relationships were based on time series data for each of the species/estuary combinations. Human population and dredging activity were used as proxies for pollution measures in all of the regressions. Measures of dissolved oxygen and/or loadings of sewage or biochemical oxygen demand were also used in three of the estuaries. A measure of stock abundance for each estuary and species was constructed from local and statewide data on commercial landings and state level data on effort.

The results of this study are difficult to summarize. The dissolved oxygen measures were of the expected sign and significant for many (but not all) of the species that spend all or part of their life cycle in the estuarine area. But the volume of dredged material was also positive and significant in many regressions.

I see at least one important problem in applying the results of this study to the valuation of pollution control in recreational fisheries. It is difficult to know how much confidence to place in the constructed stock abundance variable. The use of this variable in a time series analysis

requires the assumption that the matchability coefficient or catch per unit of effort is stable over the period of time being covered. Otherwise, changes in the constructed measure of abundance could be due to other factors rather than changes in pollution.

Another problem is that at least for some species, a priori reasoning suggests that the link between measures of pollution and catch rates or species abundance may be very weak. Some of the species for which economic studies exist are essentially off-shore species. They would be unlikely to be directly affected by water pollution. Examples include salmon before they return to fresh water for spawning and king mackerel.

Striped bass and salmon are two species that appear to have high recreational value and that are experiencing adverse effects in several ways from a variety of types of human activity. For both species over harvesting is surely one contributor to their difficulties. In the case of both atlantic and pacific salmon, there have been reports of concerns about excess fishing mortality from off-shore fishing, especially with gill nets or drift nets. Salmon are also adversely affected by hydroelectric development in their spawning rivers and by logging on the adjacent land (Loomis, 1988). As for the striped bass, it may prove to be very difficult to sort out the contributions to the recent decline of population from loss of submerged aquatic vegetation in the Chesapeake Bay, herbicide pollution from agricultural runoff, over harvesting, and perhaps other factors.

In summary, we have a poor understanding of the links between water pollution control policy and those attributes of marine recreational fishing that are valued by individuals. This appears to be the principal barrier to developing credible estimates of the economic benefits of controlling water

pollution in marine waters.

VI. THE TRANSFERABILITY OF VALUE MEASURES

The fourth question identified in the Introduction was, "Is it feasible, and if so, under what conditions, to use the value information obtained for specific sites and/or activities to estimate values of changes in activities or attributes at other recreation sites?" In other words, do we know enough about the values associated with marine recreation activities to perform "benefits transfers" in which value measures taken from a "study site" are used to calculate the benefits of proposed changes at a "policy site"? This is an interesting question because of the large number of reported values (at least for recreational fishing) reviewed in this report.

A more important problem for those considering benefits transfer in this area is the wide range of values reported for both site access and changes in quality. Two studies of the same site can produce different estimates of value either because of differences in the characteristics of individuals in the sample or differences in the methodology, models, and estimation techniques used in the analysis. And in addition, different sites can have quite different values because of differences in characteristics, markets seined, etc.

One of the striking things revealed by this survey is the heterogeneity of the present list of study sites. Some study sites have values only for a single species or species groups even though other species may be available at those sites. Other study sites have values for all species combined. Some study sites define the geographic extent to their markets in a very narrow way, for example, by estimating values only for residents of a county or

state, while others draw their samples from all users of the site regardless of their residence. And finally, there is great heterogeneity in the ways various studies define the site itself. For example, some studies estimate values for specific points of access such as a marina or boat ramp (Kaoru and Smith, 1990 and Kaoru, 1991). For others, the "site" is the entire coastline of a state and its adjacent waters (for example, McConnell, et al. , 1992). Obviously, it is important for the study site to match the characteristics of the policy site.

Even in those few instances where several studies value the same species in similar circumstances (for example, pacific salmon), estimated values span a wide range. We do not at present have a good understanding of the sources of this variation. However, the results of some recent research suggest that one possible source of this variation has to do with the choices made in the process of fitting data to a model to generate a welfare measure and the effects of the choice of a model and functional form on the welfare measure. Several studies have shown that welfare measures can be sensitive to the choice of a model and/or the choice of a functional form for a specific model. Some of these studies involve simulations in which the "true" welfare measure is known and can be compared with estimates derived by fitting the simulated data to alternative models. For example, Kling (1988) has used a Monte-Carlo simulation strategy to investigate the properties of welfare measures derived from the pooled and typical trip travel cost models and the logit model. She specified three alternative forms and parameters for utility functions, solved the constrained maximization problems to generate site visitation data, and estimated the recreation demand models with the simulated data. She then estimated welfare values for specified changes in site qualities using the

estimated models and compared these estimates with the known "true" welfare values calculated from the specified utility functions. The pooled model generally performed poorly. When the pooled model was reestimated in a Tobit form, it gave good results for one of the specified utility models. And the typical trip model also gave good results for one utility function but poor results for the other two utility functions. The logit model performed poorly for all of the utility functions.

Other studies have involved examining the sensitivity of welfare estimates to changes in some aspect of the specification of the model being applied to real data. For example, Smith and Kaoru (1990) investigated the effects of aggregating sites on the calculated welfare measures. And Kaoru (1991) found that applying a nested RUM to the Kaoru and Smith data yielded different welfare measures. Finally Huppert (1989) and Milon (1988b) found big differences in welfare measures as they used different models and estimation techniques.

Since the true model can not be known, we must add model uncertainty to the list of sources of uncertainty in welfare measures. An important area for future research is to obtain a better understanding of the sources and properties of this source of uncertainty.

VII. CONCLUSIONS

The basic question posed at the beginning of this Report was "whether the available economics literature provides a basis for estimating the benefits to marine recreation attributable water pollution control programs. There is now a substantial body of empirical literature that provides estimates of the value of access to beaches and to marine recreational fishing

sites and fisheries. This literature employs several revealed preference methods such as the travel cost and random utility models as well as contingent valuation methods. This literature also establishes that several measures of pollution adversely affect the values of trips to beaches and that improved fishing success and higher catch rates are usually valued by recreational anglers.

However, as this review has shown, there is substantial variation in value measures across studies. And there is now the realization that welfare estimates appear to be quite sensitive to the choices made about model specification and estimation. Different models applied to the same data may yield quite different value measures. Theory may provide no guidance as to which model is "correct." And statistical tests of goodness of fit may be inconclusive, as well. Also, in the case of marine recreational fishing, which is the activity that has been studied the most, the links between policy and the attributes of the activity that people value (catch rate) have not been established.

In my study of the national benefits of air and water pollution control prepared for the Council on Environmental Quality (Freeman, 1982), I estimated that the benefits to marine recreational fishing associated with achieving the objectives of the Federal Water Pollution Control Act by 1985 would be about \$2.1 billion per year with a range of uncertainty of \$.2 - 6.3 billion (1991 dollars). I also estimated benefits to swimming and boating of about the same order of magnitude. However these estimates were for fresh water and marine activities combined. The basis for these estimates was a review and synthesis of the then available empirical literature on the valuation of recreation activities plus a large element of my own judgement. The estimate for marine

recreational fishing was based entirely on a study by Bell and Canterbury (1975). These authors used secondary data from a number of sources to derive relationships between water quality and biological productivity and productivity and the number of participants and days of sport fishing. Their study yielded an estimate of the benefits of pollution control that seemed implausibly high relative to the range of estimates produced by several **studies of fresh water recreational fishing.**¹²

Are we in a better position today to assess either the benefits of attaining the targets set by past national pollution control policy or to project benefits from some new national initiative? On the one hand, we have many more building blocks in the form of studies of the values of site access and changes in characteristics. A review of the values reported in Table 2 suggests a range of values per person per trip for access to a variety of multispecies fisheries of, say, \$10 - 100. With something of the order of 50 million trips in a typical year, the total welfare value of access to marine fisheries resources could lie in the range of \$0.5 - 5 billion per year. Similarly, from Table 4, the annual value of access to a variety of multispecies fisheries could be in the range of \$100 - 1,000 per person per year. With approximately 10 million participants in marine recreational fishing, this suggests a total welfare value of \$1 - 10 billion per year.

However, as noted above, the missing link for analysis of policies is information on how these policies would affect the characteristics of the fishery resource that people value, in particular, catch rate or success rates. Looking back on things, I would be surprised to learn that the Federal Water Pollution Control Act (FWPCA) of 1972 had affected marine recreational

¹²For a more detailed discussion, see Freeman (1982), pp. 158-161.

fishery values by as much as 10% in aggregate. Although species that are dependent upon estuaries such as the striped bass appear to have high value and may have been significantly affected by water pollution in certain areas (for example, the Chesapeake Bay and San Francisco Bay), the water quality problems of these waters have proven **to be difficult to correct and the causes** of harm to these species have proven to be more complex. Thus , although there may be substantial economic value in improving the health of highly valued species such as striped bass and salmon in the future, it is difficult to conclude that the FWPCA-72 has already resulted in significant benefits to these species.

It appears that an upper bound estimate of the marine recreational fishing benefits associated with FWPCA would be substantially lower than my earlier assessment, perhaps no more than \$1 billion per year. And the most likely value would be some fraction **of that.**

APPENDIX

SUMMARY DESCRIPTIONS OF INDIVIDUAL STUDIES

This Appendix contains descriptions of each of the marine recreation studies referred to in the body of the report. Each description included summaries of the value measures derived by the study. All of the value measures reported in this appendix have been converted to 1991 dollars by the use of the consumer price index.

Agnello (1989)

Agnello utilized a travel cost model to estimate the marginal and average values per fish caught by anglers targeting bluefish, summer flounder, or weakfish. The survey area was the Atlantic Coast from New York to Florida. Data are from the 1981 Marine Recreational Fisheries Statistics Survey. Fishing success was measured by the total number of fish of all species kept on the trip on which the interview took place. This variable was positive and significant in all equations.

When estimated by weighted least squares, the standard travel cost model yielded the following values per fish:

Bluefish		Flounder		Weakfish	
<u>First</u>	<u>Mean</u>	<u>First</u>	<u>Mean</u>	<u>First</u>	<u>Mean</u>
\$6.85	\$1.63	\$21.28	\$11.09	\$7.19	\$2.15

The author also estimated a model in which anglers were assumed first to determine the number of fishing trips per season and then to choose a travel distance. Thus travel cost was the dependent variable in a regression. The values derived from this approach were substantially lower than those from the standard model, never more than 50 percent of the values listed above.

Agnello and Han (1992)

The authors utilized varying parameters travel cost model to estimate values for all fishing in the Long Island area. The fishing quality measure was the mean catch rate of all anglers for each site. The travel cost model included the price of a substitute site. The catch variable was positive and significant in most of the model specifications. The ordinary consumer surplus per trip in the model with site substitution was \$23.84. The increase in consumer surplus per trip for a 20 percent increase in catch was \$1.31. The value of doubling the catch was \$5.95 per trip.

Arndorfer and Bockstael (no date)

In this study, the authors report the results of a travel cost analysis of demand for charter boat fishing from two ports in northwest Florida. They also report both referendum CV and travel cost values for changes in the bag limit for one of the target species, king mackerel. The data are from an intercept survey with mail follow-up conducted over a four month period in the latter months of 1985. Thus it captures behavior only during part of a season. Three quality variables were included in each regression equation: actual average catch of pelagic species, actual average catch of bottom fish species, and expected catch of king mackerel. With one exception, coefficients on catch variables were positive. The pelagic species catch rate variables were all significant. But the king mackerel coefficient was significant in only one specification.

The annual consumer surplus varied from \$399 to \$1,387 depending upon the model specification. Given the mean number of trips per respondent this amounts to between \$222 and \$770 per trip. Values for changes in the bag

limit ranged from \$1 to \$10 depending on whether the limit was one, two or three fish and depending upon the model specification. The median value for a postulated increase in expected catch of one fish per trip ranged from \$250 to \$400 (or \$140 to \$220 per trip).

The referendum CV question asked if people would be willing to pay a given amount for a one unit increase in the Florida state bag limit. The median willingness to pay was only \$5.72. The authors suggest that this low value in comparison with those from the travel cost model resulted from individuals' beliefs that the bag limit was not enforceable and that it applied only to catch within the three mile limit of state jurisdiction.

Bell (1989)

In this study, Bell provides estimates of the value of coastal wetlands in Florida in supporting commercial and recreational fisheries. The author estimated the marginal productivity per acre of wetlands. The marginal productivity was measured in terms of weight and number of fish caught. The value data came from Bell, Sorenson, and Leeworthy (1982).

Bell and Leeworthy (1990).

Bell and Leeworthy utilized a variation on the travel cost model to estimate the recreational value of all of the beaches of coastal Florida. The data come from a survey of tourists as they left the state either by plane or private auto. The tourist interviews were conducted at airports and major highways. Respondents were asked questions about length of stay, origin of trip, and number of days spent at coastal beaches. To account for differences in the number of days spent in Florida across the sample, the authors

developed a variation on the travel cost model in which the number of days spent at the beach depended negatively on the cost per day in Florida and **positively on the cost of the trip to Florida.**¹ There was no beach quality variable in the travel cost equation.

Average consumer surplus per visit to Florida was \$235. The number of days at the beach varied across individuals. The average consumer surplus per beach day was \$50.40. Based on an estimate of total tourist beach days in Florida, the authors estimate an aggregate consumer surplus of \$3.1 billion per year. The time cost of travel was not included in the model. So these value measures may be biased downward.

There is a conceptual problem with this model. The implicit price of a beach day is the cost of staying in Florida for one day (lodging, meals, etc.) , prorated by the percentage of each day spent at the beach, plus the cost of traveling from the place of lodging to the beach and back. The implicit price of a visit is not exogenous to the individual. As Shaw (1991) has pointed out, the calculated price depends in part on how long one stays at the beach each day. Furthermore, this price. also depends upon the individual's choice of a place to stay, preferences for restaurants , etc.

Bell, Sorenson, and Leeworthy (1982)

As part of a survey to determine the economic impact of saltwater recreational fishing in Florida, both residents and tourists were asked an open ended CV question about how much the annual cost of fishing to them would have to increase in order for them to stop fishing. The surveys were

¹See Hof and King (1992) for an elaboration of the theoretical foundation of the welfare measure estimated in this study.

conducted in 1980 and 1981. The tourist interviews were conducted at airports and major highways. For all residents, the mean willingness to pay per day was \$57.57.

The mean willingness to pay per year was \$1,114.73. Results were also disaggregated by region. The highest values were for people fishing in the Southern part of the state. For tourists, the mean willingness to pay per day was \$45.11. The mean willingness to pay per year was \$243.20.

Bergland and Brown (1988)

In this study, the authors utilized a nested random utility model to value ocean salmon fishing in Oregon. The sample consisted of anglers who are targeting ocean salmon. The source of the data was an intercept survey carried out at ten ports on the Oregon coast by the Oregon Department of Fish and Wildlife. Because the survey did not gather income data, the model was estimated using median income from the Census for zip code of the respondent. Catch rates for the three species of salmon were utilized. The coho catch rate was positive and highly significant. The Chinook catch rate was positive but not significant and the pink salmon catch rate was negative and highly **significant.**²

The estimated equations were used to calculate the average consumer surplus for closing down one of the ten coastal ports (Bookings). The consumer surplus was approximately \$350.

²The explanation for this may be that pink salmon is a less desirable sports fishing species and the catch rates for pink salmon are about two orders of magnitude lower than the catch rates for coho and chinook salmon.

Bergstrom, et al, . (1990)

The authors report on a referendum contingent valuation study based *on* on-site interviews at 88 boat launch sites in southeastern coastal Louisiana. Respondents were engaged in a variety of water based recreational activities including water fowl hunting, fresh water fishing, saltwater fishing, recreational shrimping, and recreational crabbing. Respondents were asked questions about willingness to pay to preserve their bag or catch per day at current levels, at 40 percent of current level's, and at 25 percent of current levels. The mean willingness to pay for current levels of protection was \$446 per year.

Bockstael, Hanemann, and Kling (1987)

The authors utilized a RUM analysis of beach use in the Boston Area. The data came from a survey of households in the Boston area conducted in 1974. These data were also utilized by Feenberg and Mills (1980). Concentrations of oil, chemical oxygen demand (COD), and fecal coliform bacteria were significant in the logit equation for choice of a beach to visit. The model was used to calculate benefits for a number of changes on a per visit basis and per person for the season. The results are as follows:

Quality Change	\$ per Trip	\$ per Season	Aggregate Value ³ (per year)
10% Reduction in oil	\$.14	\$2.65	\$6.9 million
10% Reduction in COD	.33	7.31	19.3 million
10% Reduction in fecal coliform	.06	.52	1.4 million

³Calculated by the author using 2.63 million people over age 18 as reported in Feenberg and Mills (1980).

30% Reduction in oil	.55	12.86	34.0 million
30% Reduction in COD	.80	19.73	51.9 million
30% Reduction in fecal coliform	.33	7.87	20.7 million
30% Reduction in three pollutants - all beaches	1.38	33.23	87.5 million
30% Reduction in three pollutants - eight downtown beaches	.75	16.12	44.4 million

Bockstael, McConnell, and Strand (1989a)

This study has four components. The first is a referendum CV for improved water quality for "swimming and/or other water activities." The second is a varying parameter travel cost model for the use of beaches on the Maryland portion of the western shore of Chesapeake Bay. The third is a varying parameter travel cost model for boating activities in which the sample consists of boat owners who trailer their boats to the site of the activity. The fourth is a pooled travel cost model for striped bass fishing.

In the CV study, people who found the water unacceptable for swimming and/or other water activities were asked whether they would accept a tax increase ranging from \$5 to \$50 per year in order to improve water quality so that it was acceptable for swimming. The calculated mean willingness to pay for those who used the Bay for recreation was \$159. For those who had not used the Bay, the mean willingness to pay was \$50. When the mean willingness to pay is extrapolated over the population of the Washington and Baltimore SMSA's, the aggregate willingness to pay is about \$88.5 million for users and about \$30.9 million for nonusers.

The data for the travel cost model came from a survey of 484 people at

11 public beaches on the western shore of the Chesapeake Bay in Maryland. In the first stage of the varying parameter travel cost model, travel cost equations were estimated for each of the beaches. In the second stage, the coefficient on own price and the constant term were regressed on a measure of water quality. The water quality measure was the product of the concentrations of nitrogen and phosphorus in the water at the monitoring site nearest to the beach in question. The coefficient on own price was negative and significant in the second stage regression.

This model was used to calculate the willingness to pay for a 20 percent improvement in water quality measure (that is, a 20% reduction in total nitrogen and phosphorus. The aggregate benefits ranged from \$22 million to \$59 million, depending on the method of calculating benefits. The best estimate was \$45 million. It is not possible to compute the willingness to pay per household on the basis of the information contained in the report. But if the relevant population is taken to be that of the Washington DC and Baltimore SMSA's, this amounts to about \$80 per household. This may be an upper bound estimate, since the population using these beaches may include residents outside of these two SMSA's.

The estimates of boating values were based on a varying parameter travel cost analysis of data from a mail survey of registered boat owners in Maryland. The analysis was limited to owners who trailer their boats to various points of access to marine waters. The water quality variable was the product of nitrogen and phosphorus concentrations. This variable was negative and significant in the second stage equation for the own price coefficient. The estimated benefits for a 20 percent reduction in this measure ranged from \$.9 to \$10.7 million per year depending upon the method for calculating

benefits. The "average" estimate is \$6.2 million per year, or about \$78 per boater.

The analysis of striped bass anglers was based on a pooled travel cost model utilizing data extracted from the 1980 National Survey of Fishing, Hunting, and Wildlife-associated Recreation. The authors extracted data for respondents who were Maryland residents, went saltwater recreational fishing in Maryland, and targeted striped bass. The dependent variable was fishing days, since a trip measure was not available. The independent variables included the trip cost to the area in which fishing took place and each individual's average number of fish caught per trip. The catch rate variable was positive and significant. The benefits of a 20 percent increase in individuals' catch rates ranged from about \$.9 million to \$2.7 million, depending on the method used to calculate values. The "average" estimate was \$1.8 million per year. From the data reported, it is not possible to calculate a per person or per trip value.

Bockstael, McConnell, and Strand (1989b).

The authors applied a nested random utility model to data from an intercept survey and follow up telephone interviews of anglers on the Atlantic Coast of Florida. Respondents were asked questions about all marine fishing trips taken during November and December of 1987. Responses were disaggregate by groups of target species (e.g., small game, bottom fish, big game) and mode. Sites were coastal counties. The quality variable was catch rate or success rate by mode and target species group. This variable was positive and significant in the equation explaining site choice.

Access values per choice occasion ranged from \$0.97 to \$9.53 depending

upon the county. Most of the values were in the range of \$2.00 to \$4.00 per occasion. Since in the nested model structure, one option is to choose not to fish, there are more choice occasions than visits to a specific site.

Therefore, the values per actual visit to each site will be greater than the values reported here. But since the probabilities of visiting each site were not reported, it is not possible to calculate values per visit to any sites,

The values per choice occasion for enhancing quality by 20 percent, averaged across the whole sample were:

Small game fish catch rate	+20%	\$0.40
Non-targeted success rate	+20%	0.38
Bottom fish catch rate	+20%	1.52
Big game success site	+20%	1.87

At this stage in the nested model structure, each choice occasion represents a trip. Therefore, these values can also be interpreted as values per trip.

Cameron (1988a)

The author used a subset of the Cameron and James (1987) closed ended referendum CV data to estimate directly the inverse Hicksian demand functions of respondents. These were used to estimate the willingness to pay for a trip and willingness to pay for changes in certain attributes of the trip. The survey data were from salmon anglers in British Columbia. The number and weight of salmon caught were significant determinants of willingness to pay.

The willingness to pay per trip was \$34.22. The willingness to pay for a one fish increase in the total catch was \$3.13. The willingness to for one

pound increase in the weight of the largest salmon caught was \$0.78.⁴

Cameron (1988b)

This study employed Cameron's censored logistic regression model to analyze responses to a referendum question administered to recreational anglers at intercepts on the Texas Gulf Coast in 1987. The question was about willingness to pay for one year of access to the fishery. Responses differed according to the region in which the intercept took place. Questionnaires were administered during creel surveys. The total number of fish caught on the interview day was positive but not significant in any of the model specifications. The addition of a set of six water quality variables to the regression equation had mixed results. Total non-filterable residue, total phosphorus, and chlorophyll-A were positive and significant. It is not clear to me what these variables represent and whether there is any mechanism linking them to fishing success or any other aspect of the quality of fishing. Another quality measure (loss on ignition, bottom deposits, in g/kg) was positive but not significant. Measures of chromium and lead in bottom deposits were both negative but not significant.

No welfare measures were reported. All results were in the form of elasticities.

Cameron (1992)

In this study, Cameron estimated the value to anglers of the abundance

⁴Although it is not stated in this report, these are apparently Canadian dollars. Given the exchange rate in 1984, the values in US dollars would be about 77% of those reported here.

of red drum in the Texas Gulf Coast region. The author used both contingent valuation and travel cost data to estimate a single utility function for fishing days and all other goods and services. The model and data are describe in more detail in Cameron (1989a and 1989b). The data came from a survey of recreational anglers conducted by the Texas Department of Parks and Wildlife in 1987. The contingent valuation data were for a referendum question of the form: "If the total cost of all your saltwater fishing last year was (\$X) more, would you have quit fishing completely?" The data on abundance of red drum are unique in that they are based on fish population samples collected periodically by gill nets. The measure of abundance of red drum was positive and significant in the regression equation.

Both compensating variation and equivalent variation welfare measures were computed from the parameters of the utility function. Since the differences between the two measures were only of the order of 1-3 percent, here I report the mean of the two measures and refer to it as a consumer surplus measure.

For the mean level of fish abundance, the consumer surplus per year was \$4,281. The increase in consumer surplus for a 50 percent increase in mean abundance was \$1,521. The decrease in consumer surplus for a 50 percent decrease in abundance was \$936. And, finally, the loss of consumer surplus for the elimination of the red drum population was \$1,569. The activity of fishing still had value for anglers because of the availability of other species. Interestingly, the mean number of trips taken per angler was not sensitive to changes in the abundance of red drum.

Cameron and James (1987)

The authors used data from a closed ended referendum contingent valuation survey of British Columbia recreational anglers to value changes in certain attributes of the fishing trip. The number of chinook salmon caught was positive and highly significant. The number of coho salmon was negative and significant. The weights of the largest fish caught of both species were also positive and significant.

Marginal values per trip for the various attributes were: ⁵

One more chinook	\$18.96
One more coho given that number of chinook is positive	-10.40
One more coho given that number of chinook is zero	-1.57
One more pound for largest chinook	.85
One more pound for largest coho	5.70

The negative values for additional coho salmon might be explainable by the effect of a limit on the total number of salmon that can be kept per day. An additional coho reduces the number of chinook, a more preferred species, that can be kept.

Feenberg and Mills (1980)

The authors used a random utility model to estimate the value of improving certain water quality characteristics at 29 beaches in the Boston Area. The data came from a survey of households conducted in 1974. The water

⁵Although it is not stated in this report, these are apparently Canadian dollars. Given the exchange rate in 1984, the values in US dollars would be about 77% of those reported here.

quality characteristics analyzed were oil, color, and total bacteria, all of that were significant in the logit equation for predicting the choice of beach to visit.

A 10 percent reduction in these three pollutants resulted in a benefit of \$0.36 per visit. A second equation allowed for the prediction of the number of visits to each beach and calculation of benefits per person per year. A reduction in oil to a maximum of 10 mg/100ml resulted in a benefit per person per year of \$108. Extrapolation to the total population over age 18 yielded a benefit of \$283 million/year. A combined 10 percent reduction in oil, color, and total bacteria had a per person benefit of \$3.23/per year or \$1.26 million per year for the total population.

Huppert (1989)

This is a study of the combined value of the Chinook salmon and striped bass recreational fishery in the San Francisco Bay area. The study has both travel cost and contingent valuation components, and includes a comparison of TC and CVM based estimates of the value of changes in catch rate. The data come from the Bay Area Sport Fish Economic Survey of 1985-1986. The travel cost model included time valued at the wage rate. The model treated the San Francisco Bay fishery as a single site. The catch per angler averaged over at most three trips was used as a measure of fishing quality. But since the model is a single site model, this variable is probably picking up the effect of some personal characteristic that is correlated with fishing success rather than the exogenous effect of fish abundance on demand. The catch variable was positive and significant in all regression estimates.

The travel cost model was used to calculate the ordinary consumer

surplus per trip using the minimum expected loss procedure of Bockstael and Strand (1987). The results were sensitive to the method of estimation. The truncated maximum likelihood equation yielded a consumer surplus of \$77 per trip, while OLS resulted in a consumer surplus per trip of \$376.⁶ The travel cost model was then used to calculate the increase in consumer surplus per person per year for a 100 percent increase in catch rate. The results were \$207 per year for the ML model, \$141 per year for the NLLS model and \$413 per year for the OLS model. Given the reported mean number of trips per person of 6.2, these estimates imply values per trip of \$33.39 to \$66.61, depending on the method of estimation.

The parameters of the travel cost demand function estimated by maximum likelihood were used to recover the indirect utility function and to compute willingness to pay measures to avoid a 50 percent reduction in catch rate and to obtain a 100 percent increase in catch rate.⁷ These values were compared with values obtained from open ended contingent valuation questions for the same postulated changes in catch rate using a payment card. The results were as follows:⁸

	<u>TC</u>	<u>CV</u>
Willingness to Pay to Avoid a 50% loss (EV)	\$159	\$42
Willingness to Pay for a 100% gain (CV)	557	52

⁶These results are for the full model, equations (3), (6), and (9) of Table 3.

⁷The minimum required compensation for a 50 percent reduction in catch rate was also computed. But the difference between the EV and CV measures was quite small.

⁸These results are based on a truncated sample where observations with reported catch zero were deleted before the equations were estimated.

Note that these travel cost measures are different from those reported above because they represent an exact welfare measure.

Kahn (1991)

Kahn estimated the economic value of access to saltwater fishing around Long Island for those who fish via charter boats and party boats. The data came from intercept and telephone surveys conducted in 1985 through 1987. Travel cost demand functions were estimated for both types of fishing trips, The consumer surplus was reported to be \$440 for charter boat fishing and \$1,200 for party boat fishing. These are both per person per year. The report indicated that only about 20% of all fishing trips are by party boat and charter boat. So whether these data are representative of all anglers cannot be determined. The report does not state whether time was included as component of travel cost.

Kaoru (1991)

This study presents a further analysis of the data on marine recreational fishing in North Carolina analyzed by Kaoru and Smith (1990) and discussed below. Kaoru investigated the consequences of applying a nested random utility model to this data set. The highest level decision, length of trip, was assumed to be independent of catch rate and water quality variables. The second decision, region, was assumed to depend on the total loadings of nitrogen and phosphorus in the county in which the site was located. The specific site decision was assumed to depend on both catch rate the measures

of biochemical oxygen demand (BOD) and total suspended solids (TSS). These variables were calculated from loadings and flows at municipal waste water treatment plants rather than taken from direct measures of water quality. The opportunity cost of time was valued at the wage rate.

Nitrogen loadings were negative and highly significant while phosphorus loadings were positive and marginally significant in explaining the choice a region. Catch rate was positive and highly significant and TSS was negative and significant in explaining site choice. BOD was positive but not significant in this latter equation.

The welfare value of an increase in catch rate of 25 percent and by one fish were virtually identical, \$0.25 per trip. The welfare loss from closing Albemarle Sound was \$3.09 per trip. The welfare loss from closing the most popular individual site was \$1.97 per trip.

Kaoru and Smith (1990)

In this study, a random utility model was used to analyze data from a survey of marine recreational anglers in North Carolina. This is an unusual study in that it incorporated both catch and water quality variables. The catch rate was average number of fish per person per hour at each site. One purpose of this study was to investigate the effects of aggregating sites to reduce the number of choices being modelled. Three alternative specifications were utilized, one with 35 separate sites, one where some sites were aggregated into a 23 site model, and finally one where further aggregation resulted in 11 composite sites. Two alternative sets of water quality variables were used. First, estimates of nitrogen and phosphorus loadings by coastal county were used to define nitrogen and phosphorus variables for each

site. Nitrogen was negative and highly significant as expected. But phosphorus was positive and highly significant. The alternative specification utilized estimates of loadings of biochemical oxygen demand (BOD) and total suspended solids (TSS) derived from inflow, outflow, and treatment data from municipal waste water treatment plants. BOD was usually negative but significant only in the most disaggregated model. TSS was usually negative but significant only in the most aggregated model. Catch rate was positive and highly significant in all but one of the specifications

The model was used to calculate welfare changes for various scenarios. For a 25% increase in the catch rate, the welfare value was between \$7.09 and \$11.07 depending upon the water quality variables used and the degree of site aggregation. The one exception to this statement is that for the most aggregated model when BOD and TSS were employed as quality variables, the welfare value was approximately \$25 per trip. Virtually the same welfare values were obtained for a 25 percent increase in the catch rate at all sites.

The model was also used to value the loss of the most frequently visited site or aggregate of sites. For the most aggregated model, the welfare loss was \$23.90 per trip for the nutrient loading model and \$39.11 per trip for the BOD/TSS model. For two more disaggregated models, the welfare loss was between \$4.30 and \$7.77 per trip. The welfare value for a 64 percent decrease in both nitrogen and phosphorus loadings ranged from \$3.91 to \$6.15 per trip depending upon the degree of site aggregation.

Leeworthy (1990)

In this study, Leeworthy estimated the value of the Florida king mackerel fishery. A pooled travel cost model was used with data from the

Marine Recreational Fisheries Statistics Survey to estimate the demand function for anglers who target king mackerel. Catch rate variables for king mackerel, coastal pelagic, and other species were used. Leeworthy experimented with both catch rate per trip and catch rate per hour and found that the latter measure performed better statistically. catch rate per hour was positive and significant in most of the model specifications. He valued the time cost of travel at zero.

He found the average consumer surplus per trip to be \$56.54 and average consumer surplus per angler to be \$1,376. The model was also utilized to value changes in the catch rate for both the east and west coasts of Florida. The values are:

<u>East Coast of Florida</u>	<u>Per Trip</u>	<u>Per Angler</u>
25% increase	\$ 17.76	\$ 738.00
50% increase	121.99	1,341.00
25% decrease	-11.04	-953.00
50% decrease	-53.83	-2,294.00
 <u>West Coast of Florida</u>		
25% increase	\$ 24.73	\$ 464.00
50% increase	44.94	844.00
25% decrease	-31.90	-599.00
50% decrease	-56.55	-1,061.00

Leeworthy (1991)

Leeworthy estimated a standard travel cost model of the demand for visits to the John Pennekamp Coral Reef State Park and Key Largo National

Marine Sanctuary in Florida. The source of the data was a set of on site interviews of visitors. There was no quality variable. Only consumer surplus per person per day figures were reported. The interpretation of these figures is difficult because the summary data indicate substantial variation in the number of days per trip across visitors with a mean number of days per trip of something over 2.5. The estimation of a single travel cost demand function when the duration of the visit varies across individuals is problematic.

Various consumer surplus figures were reported for different functional forms, treatments of the opportunity cost of time, and treatments of sources of regression error in calculating consumer surplus (Bockstael and Strand, 1987). Consumer surplus per person per day ranged from \$223 *to* \$886 for the linear functional form and from \$637 to \$3448 for the semi-log form.

Leeworthy and Wiley (1991)

The authors estimated is a standard travel cost model of the demand for visits to Island Beach State Park on the New Jersey coast. The source of the data was a set of on site interviews of visitors. There was no quality variable. Only consumer surplus per person per day figures were reported. Virtually all visits were for one day or less. Various consumer surplus figures were reported for different functional forms, treatments of the opportunity cost of time, and treatments of sources of regression error in calculating consumer surplus (Bockstael and Strand, 1987). Consumer surplus per person per day ranged from \$24.74 to \$30.67 for the linear functional form and from \$17.76 to \$26.88 for the semi-log form.

Loomis (1988)

In this study, a multi-site travel cost model was used to estimate the marginal values per fish caught for both fresh water and ocean salmon fishing and fresh water steelhead fishing in Oregon and Washington. The travel cost data were gathered in 1977. The time cost of travel was valued at one-third the wage rate. The quality variables were total catches of the relevant species at the sites being modeled. These variables were all positive and significant in the regression equations.

The marginal values per fish depended upon the site and the species. Marginal values per fish for steelhead (which are all caught in freshwater) ranged from \$30.13 to \$134.93. Salmon caught in freshwater ranged in value from about \$9.80 to \$23.38, depending on the river. The values of salmon caught in the ocean ranged from about \$28 to \$85, depending on the port of access.

McConnell (1979)

McConnell estimated consumer surplus per person per year for fishing for winter flounder in Rhode Island. He estimated both a household production function model and travel cost model. The data came from a survey of recreational anglers in Rhode Island.

In the household function model, purchased inputs are combined to produce both fishing days and number of fish caught. The biological abundance of fish was an argument in the production function for catch. Although abundance was not observed, catch was; and the model permits the calculation of consumer surplus from the fishing activity. The annual consumer surplus

for the average angler was \$1,159.⁹

The travel cost model did not include prices of substitute sites. The treatment of time in the calculation of travel cost is not specified. The consumer surplus per angler is \$524. Although catch rate entered positively in the travel cost demand function, it was not statistically significant. Therefore, the author did not attempt to value changes in catch rate.

McConnell (1986)

In this study, McConnell estimated the impact of polychlorinated biphenyl (PCB) pollution on the economic value of three urban beaches on New Bedford Harbor. The method was a standard travel cost model utilizing hypothetical data on numbers of visits obtained from a telephone survey of households in the New Bedford Area. Households were asked how many visits they planned to make to beaches on the harbor during the coming year (1986). Also, if they indicated awareness of the present pollution of harbor sediments with PCBs, they were asked how many visits they would make if harbor sediments were cleaned up. Since two of the beaches were close to each other and considered very close substitutes, they were treated as one unit: East-West Beach. The estimated visit demand functions take account of the substitute relationship between the two beaches. The major question about this study is the validity of responses to hypothetical activity questions.

The results were as follows:

Damage per household aware of PCBS per year	Aggregate damage per year
--	------------------------------

⁹The date of the survey was not reported. I have assumed that the data were for 1977 and converted them accordingly to 1991 dollars.

East-West Beach	\$3.57	\$144,000
Fort Phoenix	\$4.10	\$165,000

McConnell, et. al. (1992)

This study has three components. The first is an analysis of to responses to a referendum CV question about willingness to compensation for a loss in access to saltwater recreational fin fishing in the state in which the intercept interview took place. The second component consists of a direct referendum willingness to pay question asked of those anglers who took an overnight trip for fishing. Analyses were conducted for each state from New York to East Coast of Florida. The third component is an application of the random utility model to the data collected from the intercept and telephone surveys. Since the results of the latter two components are labelled as preliminary and not for citation, only the results of the referendum CV question are reported here.

Responses to the referendum question were disaggregated by species group targeted by the respondent: big game, small game, bottom fish, flat fish, and other. Quality variables were an individual's catch rate or success rate. But a unique feature of this study is that the individual catch rates were not taken from direct observation but were modeled as the outcome of a random process depending upon both individual characteristics and some measure of abundance, for example, aggregate catch rate. The catch rate variables were correctly signed and significant.

Average willingness to sell the right of access to fishing in the state

during a two month period varied across states and by season. For the summer months (July and August) values were in the range of \$250 to \$450 per angler. For the winter months (January and February) values were much lower, especially in the north. An exception to this is New York where the access value was \$90, reflecting the value of the winter flounder fishery. The average across all states was \$104 reflecting the higher values for South Atlantic states, especially Florida. Access values for a twelve month period range from a high of \$872 per angler for New York to \$755 in North Carolina.

These equations were also used to calculate the value per angler per year for a one fish per day increase in average catch rate, by species group and by state. The highest value was for big game fish in Florida (\$950). Other high values for big game were found in North Carolina, Virginia, and Maryland, all in the range of \$154-179. Anglers placed a relatively high value on increasing catch of small game fish in Georgia (\$1.96); but more than half of the states had values of less than \$1.00. The values for increased catch of bottom fish ranged from \$0.19 to \$0.62 per angler, except in Georgia and Florida where they were less than 3 cents per angler. Flat fish were relatively highly valued. The highest value for increasing catch was in New York where the value was \$0.96 per angler. Most states were in the range of \$0.40 to \$0.60 per angler.

Milon (1988a)

In this study, Milon used a nested multinomial logit model to estimate the value of adding a new artificial reef fishing site to the coastal water off Dade County Florida. The data came from a 1985 survey of Dade County boat owners who used their boats for recreational fishing. The quality variable

was mean catch in pounds per hour by site at the seven existing artificial reefs sites. Catch was positive and significant in the regression equation.

Depending upon the location of the hypothetical new site, the annual value per angler ranged from approximately \$2.00 to \$2.30. These values are the average across all anglers in the sample, not all of whom would fish at an artificial reef site.

Milon (1988b)

In this study, Milon used the same data as Milon (1988a) to experiment with alternative model specifications. The models estimated included single site models both with and without substitute site prices, a pooled site model estimated by both ordinary least squares and by Tobit, and a multinomial logit model that allocated the total number of trips to artificial reefs among the seven sites. The catch variable was positive in all models and highly significant in all except the RUM equation.

The welfare measures derived for adding a reef are not comparable to those given in Milon (1988a) since each of the alternative models uses data only from anglers actually fishing at least at one of the artificial reef sites. Mean annual values for artificial reef anglers were:

Single site with substitute prices (seemingly unrelated regression model)		\$23.85/anglers/yr
Pooled site (Tobit)		\$25.92/anglers/yr
Multinomial logit		\$7.81/anglers/yr.

Milon (1988c)

In this study, Milon applied both a pooled travel cost model and a random utility model to value changes in average catch and in the bag limit for the king mackerel fishery along the Gulf Coast. The data came from the Marine Recreation Fisheries Statistics Survey of 1986. The data were for individuals who are targeting king mackerel. Several alternative "catch" and "keep" quality variables were employed. The value estimates utilize average number of king mackerel kept per angler. The quality variables were positive and significant in most instances.

Values were reported for travel cost equations based on both a time cost of the minimum wage rate and a time cost of zero. Only the former are reported here. The results can be summarized as follows:

<u>Pooled Travel Cost</u>	<u>Per Trip</u>	<u>Per Angler</u>
Plus 25% in catch	\$3.00	\$ 84.07
1 fish bag limit	-\$5.33	-\$149.46

<u>RUM</u>	<u>Per Trip</u>	<u>Per Angler</u>
Plus 25% in Catch .		
Southwest Florida	\$27.80	\$771.55
Northwest Florida	8.95	250.75
Alabama and Mississippi	16.53	462.93
Louisiana	0.69	19.29
Average - 4 sites	\$13.43	376.13

Minus 25% in Catch

Southwest Florida	-\$13.09	-\$366.44
Northwest Florida	0	0
Alabama and Mississippi	-11.02	-308.51
Louisiana	-0.21	-5.79
Average - 4 sites	-5.20	-170.23

One Fish Bag Limit

Southwest Florida	-\$15.83	-\$443.65
Northwest Florida	0	0
Alabama and Mississippi	-6.20	-173.60
Louisiana	0	0
Average - 4 sites	-5.51	-154.31

The values from the pooled travel cost model are comparable to those from the random utility model, especially for the one fish per angler bag limit. The results from the random utility model show a high degree of variation across the four geographic areas included in the analysis. Losses for reduction in catch rate in bag limit are sometimes zero. This is because of those areas already have low catch rates and catch rates below the one fish bag limit.

Milon (1991)

Milon used data on anglers targeting king mackerel in the Gulf of Mexico during 1986 from the Marine Recreational Fishing Statistics Survey to estimate a pooled travel cost model. Milon employed two alternative specifications to reflect quality. In the first, a total catch variable was included. It was

positive and significant in the travel cost demand equation. In the second specification, separate measures of kept catch and released catch were used. Both measures were positive and significant; and the second specification provided a better fit to the data.

Milon also estimated the increase in annual consumer surplus per angler for a 25 percent change in each of the catch rate measure employed in this analysis. The results are summarized as follows:

	<u>25% Increase</u>
Total Catch Rate	\$ 85
Kept Catch Rate	\$ 61
Release Catch Rate	\$ 99
Both Kept and Released Rate	\$158

Milon (1993)

In this study, Milon replicated the results of his earlier pooled site travel cost model of the king mackerel fishery (Milon 1988c). Travel cost equations were estimated utilizing both 1990 and 1991 data from the Marine Recreational Fisheries Statistics Survey. In contrast to the earlier study, catch rate variables showed ". . . little consistency and were generally not statistically significant in either year (p. 3-2)." In the discussion of this unusual finding, Milon notes that both the catch rates and the percentage of survey respondents targetting king mackerel have increased since the year of the earlier data. Milon suggests that the catch rate may have a greater effect on the decision to target this species rather than on the number of trips taken by those who have chosen to target the species. It would be a more appropriate to model separately the decision to target a species and the

choice of the number of trips. The nested RUM model would be appropriate. There were no estimates of the economic value presented in this report.

Milon et al. (1993)

In this study, a contingent valuation questionnaire was administered by mail to a sample of Florida residents who had been identified in the 1991-92 Marine Recreational Fishing Statistics Survey as having fished in the prior two months. Subsamples were asked questions about the willingness to pay for various combinations of changes in bag limits, changes in average catch, and changes in size limits for one of six species. The payment vehicle was special license stamp. Results were summarized in terms of an average annual value for the specified management change and the average value per fish based on the expected change in the number of fish and the assumption that the individual makes one trip per year. The results are summarized as follows:

<u>Species and Valuation Scenario</u>	<u>Average Annual Value for Management Change</u>	<u>Average Value per Fish</u>
REDFISH		
<u>Bag Limit</u>		
from 1 to 2	\$1.94	\$1.94
from 1 to 3	2.87	1.44
<u>Average Catch</u>		
from 2 to 3	2.15	2.15
from 2 to 4	2.42	1.21
<u>Size Limit</u>		
from none to one over 27"	1.50	-
from none to two over 27"	2.60	-
SEATROUT		
<u>Bag Limit</u>		
from 10 to 15	1.36	0.27
from 10 to 20	1.16	0.12
<u>Average Catch</u>		
from 3 to 5	1.74	0.87
from 3 to 7	1.67	0.42
<u>Size Limit</u>		
from none to one over 24"	1.35	-
from none to two over 24"	1.36	-

MULLETBag Limit

from 50 to 75	0.66	0.03
from 50 to 100	0.67	0.01

SHEEPSHEADBag Limit

from none to 10	1.01	0.20
from none to 5	1.01	0.10

POMPANOBag Limit

from none to 4	1.44	0.11
from none to 2	0.65	0.29

KING MACKERELBag Limit

from 2 to 5	2.05	0.68
from 2 to 10	2.33	0.29

Average Catch

from 1 to 2 every 3rd trip	1.99	5.97
from 1 every 3rd trip to 1 every trip	1.85	2.78

Morey, Rowe, and Watson (1993)

The authors utilized a random utility model to estimate the value of the Atlantic salmon fishery on the Penobscot River and changes in value with postulated changes in catch rates. The data came from a mail and telephone survey of Maine Atlantic salmon license holders conducted in 1988. Travel cost included travel time valued at 1/3 of the individual's annual household income divided by hours worked. Seven other rivers or groupings of rivers were included in the choice set. The catch rate variable was the average catch per trip. Nonparticipation was one of the alternatives in the choice set. The catch rate variable was positive and significant.

The authors reported per year CV measures for doubling the catch in the Penobscot River, halving the catch rate in the Penobscot River, and eliminating the Penobscot River salmon fishery. The EV measures were reported to be very similar to the CVs. Since the distribution of individual

willingness to pay values was highly skewed, I report both mean and median values. The values are:

	<u>Mean CV</u>	<u>Median CV</u>
Double catch	\$588	\$458
50 % reduction in catch	-320	-219
Eliminate fishing	-932	-572

Morey, Shaw, and Rowe (1991)

In this study, a discrete choice, random utility model of marine sports fishing in Oregon was estimated. The model utilized data from the 1981 Marine Recreational Fishery Statistics Survey to estimate the CV associated with closing fishing in certain counties and the CV associated with all species in a county (Clatsop) and the CV associated with eliminating salmon fishing in that county. The quality variable in the discrete choice model variables were catch rates for salmon and for four other species. These are average catch rates for each county. The coefficient on salmon and two of the other species were positive.

The value measures computed are the CVs for representative residents in each of eight counties in Oregon for the loss of either shore fishing, boat fishing, or all fishing in Clatsop County. Welfare measures were also calculated for preventing the elimination of salmon only in Clatsop County and for an increase of one fish per trip for salmon. Some representative values in dollars per person per year are shown below.

Residents of:

<u>CV for Eliminating:</u>	<u>Clatsop</u>	<u>Multnomah¹⁰</u>	<u>Deschutes¹¹</u>
All shore fishing in Clatsop Cty.	-\$167.00	-\$ 91.00	-\$ 20.00
All boat fishing in Clatsop Cty.	-91.00	-50.00	-11.00
All fishing in Clatsop Cty.	-263.00	-142.00	-32.00
All salmon fishing in Clatsop Cty.	-2.52	-2.28	-0.51
CV for increasing salmon catch			
by one per trip	0.98	0.87	0.20

The low values for salmon relative to all fishing are puzzling.

Norton. Smith. and Strand (1983)

This is a study of the Atlantic Coast striped bass fishery. The method employed by the authors was the travel cost model. However, details of the model and results were not reported. The data came from the Marine Recreational Fisheries Statistics Survey of 1979 and additional survey work conducted by the study team. The travel cost model included a catch rate per trip variable. Both consumer surplus per trip and marginal willingness to pay for one additional fish caught per trip were computed for four Atlantic Coastal regions. The results

are:

	<u>Consumer Surplus per trip</u>	<u>Marginal Willingness to pay for Increase in Catch per trip</u>
New England	\$142	\$20.84
Mid Atlantic	279	12.28
Chesapeake	64	8.75
South Atlantic	146	2.21

The marginal willingness to pay for an increase in catch for New England

¹⁰The city of Portland is located in Multnomah County.

¹¹Deschutes County is in the central part of the state.

includes an adjustment to reflect the market value of fish sold by recreational anglers. This is because the survey indicates that about 60 percent of the fish caught by recreational anglers in New England are actually sold. The authors also report total number of trips and total value per year by state.

Rowe, et al. (1985)

The authors utilized a random utility model to analyze data from the National Marine Recreational Fisheries Statistics Survey of 1981. Sites were counties on the Pacific Coast, except for Southern California where some counties were aggregated into "macro sites." Travel cost included a measure of the opportunity cost of time. Species were aggregated into groups. And trips were distinguished by mode (beaches and banks, man-made structures, party and charter boats, and private and rental boats). The quality variables were average catches per trip by species group for each site. The catch rate for salmon was positive and significant. The results for catch rates of other species were mixed, with some being negative.

The authors reported per trip welfare losses for eliminating shore fishing, boat fishing, or all fishing at each site along the coast. Losses were mostly in the range of \$0 to \$10 per trip with some sites being higher. The authors also reported the value per trip for a one fish increase in catch rate for several species. Salmon were the most highly valued species. The values varied by site. For California, the value at the median site was \$8.20 per trip. For Oregon and Washington, the values were \$16.68 and \$19.58 per trip for a one fish increase in the salmon catch rate. The values for other species were in the range of \$1 to \$4 per trip. The per trip welfare loss for

the elimination of all salmon fishing in the state were:

California	\$2.43 per trip
Oregon	\$6.00 per trip
Washington	\$4.44 per trip.

Silberman, Gerlowski, and Williams (1992)

The contingent valuation study reported in Silverman and Klock (1988) also included questions on existence value for a beach nourishment program on a 12 mile stretch of northern New Jersey beaches. Present beach users were asked if they would use the beach in the future if it were improved and what would be their willingness to pay a one-time contribution to support beach nourishment because "it may worth something to you simply knowing more people will be able to use the beach or because you believe more beaches are good for your community (p. 227)." A similar question was asked of a sample of northern New Jersey residents in a telephone survey. Sample mean willingness to pay were in the range of \$10 to \$20 with those respondents anticipating future use having a higher mean willingness to pay than those who did not expect to use the beaches in the future.

Silberman and Klock

The authors conducted a contingent valuation study to estimate the value of a beach nourishment program that would result in wider beaches. The study area was a 12 mile segment of ocean beach in northern New Jersey. One sample of beach users interviewed at the beach was asked their maximum willingness to pay for a daily pass for that beach. The sample mean willingness to pay was \$4.57. Another sample was shown pictures of and given descriptions of the

results of beach nourishment programs. They were then asked about their willingness to pay in the form of a daily beach use pass to visit the improved beaches. The sample mean willingness to pay for this group was \$4.95.

The wording of the willingness to pay question may have encouraged an anchoring effect on the typical price of a one day beach pass. Also, the question format was bidding game. Each respondent was given one of three possible starting points. The authors report a significant starting point effect in the statistical analysis of their data.

Smith, Palmquist, and Jakus (1991)

The authors used the data set developed by Kaoru and Smith (1990) to estimate a hedonic travel cost model using their adaptation of the Farrell best practice frontier technique. In this model, the marginal implicit travel cost or price of an attribute such as catch rate is estimated from the additional travel cost that must be incurred to visit higher quality sites. The Farrell best practice approach infers these marginal implicit prices by utilizing only those data points for which more costly sites offer higher quality .

After estimating the hedonic travel cost function, the authors estimated the inverse demand or marginal willingness to pay function for improvements in catch rate. As predicted by theory, they found that this marginal implicit price was a positive but decreasing function of catch rate, other things constant. They also calculated the welfare gain for a postulated increase in average catch of one fish per hour (about 61%). The welfare measures are:

<u>Boat Anglers</u>		<u>Bank Anglers</u>	
Time at	Time at 1/3	Time at	Time at 1/3
Wage Rate	the Wage Rate	Wage Rate	the Wage Rate

\$1.24

\$1.28

\$1.11

\$0.70

Vaughan, et al. (1985)

In this study, the authors used a recreation participation model to estimate probabilities of participation and rates of participation in marine fishing, swimming, and boating for the United States. The data were from the 1975 National Survey of Hunting, Fishing, and Wildlife Associated Recreation. This study also included an effort to estimate the probability of owning a boat and the rate of utilization of the boat based on the Nationwide Boating Surveys conducted by the U.S. Coast Guard.

For marine fishing, the probability of participation and level of participation given that one is a participant were estimated as functions of the availability of unpolluted shoreline as measured by distance from the respondent's residence. Increases in availability of shoreline as a consequence of full implementation of the Clean Water Act effluent standards were derived from responses to a questionnaire sent to officials within the relevant state agencies. A number of model specifications and estimation procedures were used. Increases in participation were valued using unit day values from Charbonneau and Hay (1978). These values were approximately \$30 per day for inshore saltwater fishing and approximately \$100 per day for offshore saltwater fishing. Benefits for improving both Great Lakes and marine water quality together ranged from just under \$3 million per year to about \$582 million per year. But almost all of this was attributable to improvements in water quality in the Great Lakes.

Benefits associated with marine fishing were only of the order of \$2-3 million per year and this amounted to only pennies per fishing day based on

the pre-policy rates of participation. When similar models were applied to data on participation in saltwater swimming and boating, coefficients on availability variables were often insignificant and/or negative. Estimates of total benefits were negative more often than positive. The authors attribute these problems to the unreliability of the underlying water quality and availability data.

An alternative approach to estimating boating benefits took ownership of a boat as a proxy for being a participant. This approach utilized data from the U.S. Coast Guard survey mentioned above. Total benefits due to increased ownership, rentership, and intensity of use ranged from \$76 million to \$470 million per year depending upon the model specification. But again, the bulk of these benefits were due to the improvements in the Great Lakes. Estimates of the benefits due to improvement in marine water quality were quite small.

Wegge, Carson, and Hanemann (1988)

The authors employed a nested random utility model utilizing data on recreational fishing activities for South Central Alaska to estimate probabilities and values of summer freshwater and saltwater fishing by species and site for residents of Alaska. Separate equations were estimated for each week of the season with individual choice being modeled as a sequence of whether to fish, then given a decision to fish, the number of trips, species, and site.

The authors calculated the loss in welfare for closing one site (the Kenai River) for king salmon fishing for the last week in July. The welfare loss is estimated at \$598,000. The authors also reported aggregate net willingness to pay and willingness to pay per choice occasion (that is, per

trip taken to any site) by site and species group. It is possible to calculate the willingness to pay per trip for only one site/species combination from the data reported. The value per trip for king salmon fishing at the Deep Creek-Marine site is \$48.50. The authors reported willingnesses to pay per choice occasion for a number of other specific site and species combinations. These data show that the most valued saltwater species are halibut and king salmon.

Wegge, Hanemann, and Strand (1986)

This study reports the results of analyzing a mail survey of a sample of subscribers to a magazine about sports fishing in Southern California. The survey obtained data on angling activity in 1983. The authors reported annual and per trip consumer surpluses from two different travel cost demand models. One was a simple travel cost model with travel cost (not including time) as the only independent variable. This model was estimated because income was not significant when it was included and efforts to include some measure of time cost of travel were unsuccessful. In this model, total fish catch was positive and significant in all but the charter boat for one day or less equations.

The welfare measures derived from this model were as follows:

Consumer Surplus Per Year		
	<u>Boat Owners</u>	<u>Non Owners</u>
Charter Boat		
Day trip	\$ 114	\$248

A-39

Greater than 1 day	260	318
Private Boat	1,169	956
Shore	334	608

Consumer Surplus Per Trip

	<u>Boat Owners</u>	<u>Non Owners</u>
Charter Boat		
Day trip	\$ 30	\$67
Greater than 1 day	70	86
Private Boat	101	84
Shore	47	85

In a second analysis, logit equations were used to estimate the probability of participating in different modes of fishing. Then, travel cost equations were estimated using the wage rate as the opportunity cost of time for respondents indicating the ability to trade off money for time. The travel cost equations included number of fish caught per trip. This variable was generally positive but was significant in only two out of eight equations.

The calculated welfare measures are:

Consumer Surplus Per Year

	<u>Boat Owners</u>	<u>Non Owners</u>
Charter Boat		
Day trip	\$ 463	\$ 936

A-40

Greater than 1 day	1,855	2,954
Private Boat	4,261	*
Shore	1,697	*

* - Travel cost variable not significant.

Consumer Surplus Per Trip

	<u>Boat Owners</u>	<u>Non Owners</u>
Charter Boat		
Day trip	\$125	\$253
Greater than 1 day	501	799
Private Boat	373	*
Shore	237	*

* - Travel cost variable not significant

Finally, respondents were asked, "If the cost of a trip (in a specific mode) were increased by \$10 per trip, would you stop taking (mode) trips all together?" If the response was no, five additional questions were asked for higher values. Some respondents indicated no for all postulated values. A simple heuristic was used to estimate a Marshallian demand curve and consumer surplus per trip. The results are:

Consumer Surplus Per Trip

	<u>Mean</u>	<u>Media</u>
Party/Charter Boat	\$79	\$31
Rental Boat	24	21

	A-41	
Shore	16	10
Private Boat	73	41

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